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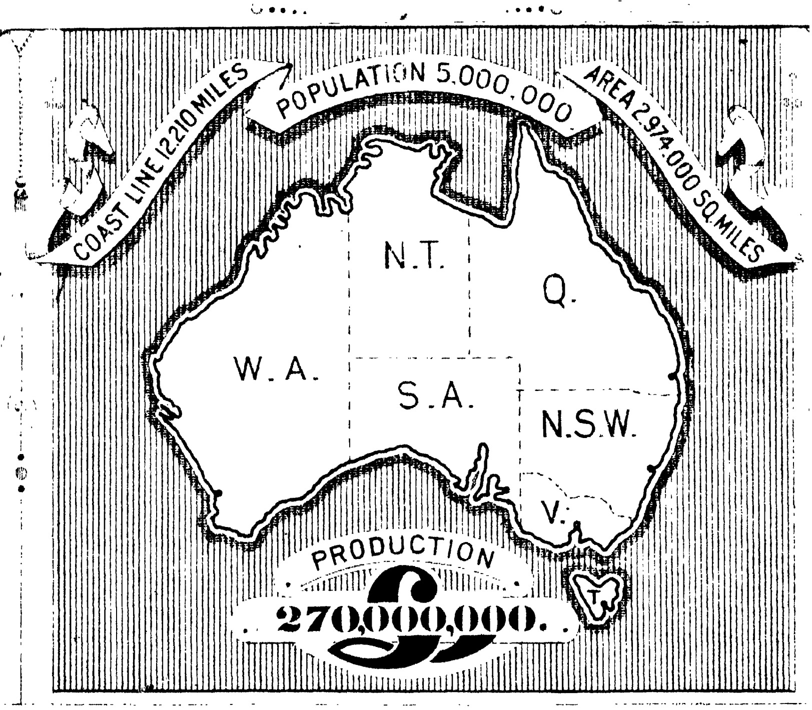

Official Journal of the Institute of Science & Industry.

Commonwealth Institute of Science and Industry

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"We must rise to this great occasion, turning a frightful calamity into a lasting good. We are beginning late, but we may at least avoid the mistakes of those who blazed the trail. Our duty is clear: our great industries, primary and secondary, must be stimulated, advised and aided by scientific industrial research and by wise laws on a scale commensurate with their national importance and value."

Inaugural Speech—*Right Hon. W. M. HUGHES, P.C., &c.,*
First Chairman of the Advisory Council of Science and Industry.

SCIENCE AND INDUSTRY.

VOL. 1.] MAY, 1919. [No. 1.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Foreword.

Conceived in war and born as one of the first fruits of Peace, this *Journal* sets out with the idea of affording a suitable and authoritative medium for the expression of Australian scientific thought and aspirations.

One of the objects of the Institute is to co-ordinate scientific work carried out in the Commonwealth. It is necessary not only that the research worker in Queensland should know what the research worker in Western Australia is doing, but he should know it promptly and accurately. It is not true that the Commonwealth Institute of Science and Industry merely intends to overlap into State spheres. Far from doing this, it will tend to obviate that large measure of overlapping that now exists. This journal will be one of the instruments by which that desirable end is attained.

As things stand to-day, scientific research work in Australia suffers severely from two desiderata. There is a paucity of trained men, and there is also a scarcity of the necessary apparatus. There are too few laboratories, and too few men to fill them. That being so, it is very essential that the best possible results should be obtained from the limited man-power and material available. The Institute cannot, nor does it wish to, dictate. Many of the scientific workers of Australia are quite beyond its control. But it can encourage, and it can itself refuse to find money for overlapping investigations.

The columns of *Science and Industry* are to be freely open to all scientific investigators, no matter whether they come directly under the ægis of the Institute or not. It will be an informative rather than controversial medium. Its standard will be high, but it will not be so lofty as to discourage the timid or damp the ardour of the enthusiastic. In its pages a strenuous endeavour will at all times be made to maintain unsullied the highest traditions of Science.

No competent scientific investigator need fear the coming of the Institute. It will not attempt to do work that others are doing already. There is more than sufficient work for all. No one needs to look round for a job. They are everywhere at hand. While there is still dust in Sydney's streets, or smoke issuing from the chimney stacks at the factories at Footscray, while there is waste timber being eternally burnt around the saw-mills of the West, while the molasses expressed from the sugar-cane of the North still finds its way down to the sea, who can deny the width of the field for scientific investigation? While the rich lands of Queensland are continually being given over to the prickly pear, and arable areas of Victoria to St. John's wort, while artesian water ceases to flow, or the bores to corrode, while stock die of strange diseases in the night, and their young perish before birth, while there are still mineral treasures that have not yet been exploited by the prospector, while air transport is still with us an undeveloped means of locomotion, while a thousand and one articles of daily use are still being imported from foreign lands that could easily be manufactured by our own people, who will say that there is no room for science?

Hitherto in Australia, and in most other English-speaking countries, the scientist is only now beginning to get back some of his own. In the past there has been observable a certain suspicion of science. The primary producer used to regard the man of science as a dreamer or at best a theorist. They talked of Collins-street farming. The scientific man, on his part, had little respect for those who allowed their actions to be hampered by the ideas of their grandparents. But gradually it was seen by producers that the man of science had something to teach them if they were only prepared to listen, and if he was willing to express his thoughts in every-day language. The man on the land no longer despises science as he did a quarter of a century ago—at least, the more progressive do not. The manufacturers are not precisely in the same plight. With some few and notable exceptions, they have been inclined to ignore the lessons of science. The scientists themselves are somewhat to blame for this, or, at any rate, they have themselves to thank. Business men have one test of value, and that is cost. Scientists who love their science place it above money. Much of the most valuable scientific work done in the world has been done for a pittance. The reward of the investigator was not necessarily expressed in the augmentation of his banking account. Business men could not understand this. Services that could be had cheaply were nasty. If they were valuable, they would be much sought after in the market. So argued these men of affairs, and this was the basis of those advertisements asking for the services of fully-qualified chemists at £200 a year or less. These bad old days must end if science is to come into her own. In the field of science the labourer is worthy of his hire.

The Institute is the youngest Department of the Commonwealth Government. It is not yet old and effete, with a large number of its officers eagerly looking for the retiring age. It represents the young Commonwealth, youthful and virile, and realizes, as it has been expressed, that "the frontier of knowledge is the starting point of research."

F. M. G.

Editorial.

PAPER FROM KARRI TREES.

The Institute has received from one of its members, Mr. C. E. Lane-Poole, Conservator of Forests, Western Australia, information regarding tests on the pulping qualities of young Australian eucalypts carried out at the Laboratory of the School of Papermaking, Grenoble, France, by M. Mathey, who states that among the species of trees introduced on a plantation in Spain there are some eucalypts which give excellent results in the manufacture of cellulose. The experiments were carried out mainly with Tasmanian bluegum felled at the immature age of 25 years or less, while previous investigations were carried out on large mature timber. Further information regarding these experiments are being obtained. If the reports received are confirmed, the cultivation of pure forests of certain species of eucalypts for pulping purposes may prove to be practicable commercially, while there may already be in existence forests of immature trees which could be used commercially for paper-pulp. Results of much interest and value have been obtained from experiments which are being carried out by Mr. I. H. Boas, Technical School, Perth, Western Australia, on the pulping qualities of karri trees. The experiments show that the yield of pulp is satisfactory, the best results being obtained from trees about eight years old. It is not improbable that even mature karri can be used to make a satisfactory paper, and Mr. Boas reports that this may offer a partial solution of the problem of utilizing the enormous quantities of waste karri at the saw-mills in Western Australia.

VITICULTURAL INVESTIGATIONS.

A fund of £1,500 has been raised by vine-growers of Merbein and Mildura (Victoria), and Curlwaa (New South Wales), taxing themselves at the rate of 2s. 6d. per ton of dried fruits produced, for the purpose of establishing an experimental station. They are desirous of securing the co-operation of the Institute in carrying out investigations into certain problems, viz.:—

(1) Control of vine diseases (pathological and entomological); the investigation and treatment of fungus and insect pests affecting the vine; and the determination of the most suitable phylloxera resistant stocks for irrigable lands.

(2) Chemical problems tests to discover more effective methods of drying grapes, manurial experiments with vines and investigational work with a view of controlling the movement of noxious salts in irrigable soils.

PRICKLY PEAR PROBLEM.

The Federal Government is still anxious to assist in tackling the prickly pear problem—one of the most serious that faces Queensland and the northern portion of New South Wales. It will be remembered that last year a proposal was made for joint action on the part of the Commonwealth and the States of New South Wales and Queensland on the basis of a five year agreement. The annual cost of the effort

was to be £8,000, of which the Commonwealth was to find half and each of the States one-fourth. The Queensland Government agreed, but the New South Wales Government has not yet done so. Now the latter Government is again being asked to consider the proposals favorably.

WHITE POTTERY CLAYS.

A Special Committee of the Institute, consisting of Messrs. M. Copland (Director of the Ballarat School of Mines), V. G. Anderson (Messrs. Avery & Anderson, Industrial Chemists, Melbourne), W. Baragwanath (Victorian Department of Mines), and W. Miller (The Eureka Pottery Co., Ballarat), has been established for the purpose of making investigations into the utilization of white pottery clays in the Ballarat district. A grant of £450 has been made for the purchase of apparatus (£150) and the salary of a skilled investigator (£300). The investigations will be carried out at the Ballarat School of Mines. The Committee has recently commenced its work, and has got out designs for certain necessary apparatus, which is being manufactured locally.

NEW SHEEP-FLY PARASITE.

Part of the work of the Committee which is making investigation in Queensland into the sheep-fly pest is to discover parasites which destroy the maggots of the flies. Large numbers of one such parasite —a Chalcid wasp—have already been bred and released with encouraging results both in New South Wales and Queensland. Now the discovery of another parasite is announced by Mr. F. H. Taylor, the Institute's entomologist attached to the Queensland Committee. This is quite unlike the Chalcid in size, build, and habits. In size it is longer and more slender, and is a jet-black colour. In habits it differs widely from the Chalcid, as it lays but one egg in each sheep-fly pupa, whereas the Chalcid lays up to 70 eggs in each fly pupa. It is also a much stronger insect on the wing than the Chalcid wasp. Its life history is now being worked out, and, as it is believed to be a new species, specimens have been sent to the National Museum, Washington, United States of America, for determination by their expert in the Chalcidæ.

POTASH FROM ALUNITE.

Since the publication of Bulletin No. 3, "The Alunite deposits of Australia and their Utilization," a number of specimens of alunite has been forwarded to the Institute for report. As a result of the experimental work carried out by the Institute, the Australian Alum Company, Sydney, proposed to carry out large scale tests, with a view to utilizing the deposits at Bulladelah, New South Wales, for the production of potash. Owing to difficulty in obtaining suitable plant, these tests have not yet been completed. Another important development is proposed in connexion with deposits in South Australia. The Sulphide Corporation has taken, under options to work and agreements to purchase, leases aggregating about 300 acres, together with other areas for which claims have been pegged. The Corporation proposes to thoroughly prospect the deposits. The methods for preparing

potassium sulphate are fully described in Bulletin No. 3. Should developments prove favorable, the Sulphide Corporation intends to send shipments to its works at Cockle Creek, New South Wales, where the potash salts will be separated. Potash will then be available as a fertilizer to be utilized in the manufacture of the Corporation's artificial manures.

SCIENTIFIC CONTROL OF ROADS.

The Institute has given a considerable amount of attention to this matter, and has collected a large body of information as to measures taken in other countries for the scientific control of road construction and maintenance, and for investigational work on road-making materials. A Committee consisting of Mr. W. Calder, M.I.C.E. (Chairman of the Victorian Country Roads Board), Mr. J. M. Coane (Consulting Engineer, Melbourne), Professor H. Payne (Melbourne University), and Mr. Gerald Lightfoot, M.A., has been appointed to prepare, for the consideration of the Executive Committee, the outline of a scheme for initiating experimental work on the subject. It is proposed to send the report for the consideration of the several State road authorities, motorists' associations, and other bodies especially interested in good roads, with a view to obtaining their support—both financial and otherwise—in the movement.

TESTING CLAYS IN WESTERN AUSTRALIA.

Important progress has been made by the Clay Committee which has been established in Perth. A large number of clays has been examined, and valuable assistance and advice has been given to persons actually engaged in the industry and to others who are desirous of developing deposits of clays. Washing tests, kiln test pieces, plasticity tests, and field examinations have been made. A large amount of successful work has been done in preparing and burning colourless glazes from local materials and in the manufacture of firebrick of the highest quality and of a good scorifier. A number of felspars, kaolins, and quartz have been investigated. Shrinkages and porosities have been calculated. Experimental porcelains have been made and cups, saucers, and lavatory basins have been manufactured from local clays with considerable success. As regards assistance to persons engaged in industry, the following examples may be given to illustrate the practical results already obtained from the investigations:—

(*a*) A cement company has been enabled to locate a clay suitable and conveniently situated for use in making Portland cement.

(*b*) A porcelain company in the eastern States has been put in touch with local sources of felspar much freer from iron than any at present available in the eastern parts of Australia.

(*c*) A large amount of technical information and advice has been given to the promoters of a new white-ware pottery to be established in Perth.

(*d*) Tests have been made and advice given in connexion with fire-resisting material for a new local glass works.

(*e*) A brick factory has been given information which will enable the quality of the products to be improved for more exacting uses.

(*f*) Advice has been given to local potters which will enable them to obtain supplies of local clays more suitable than those previously used.

It may be mentioned, moreover, that the Committee has succeeded in making highly satisfactory Segar Cones, which before the war were manufactured almost entirely in Germany. These cones are used by potters for measuring the temperatures of their furnaces, and are essential for carrying out experimental work in pottery.

ELECTRICAL STERILIZATION OF MILK.

The Committee dealing with this subject consists of Dr. J. B. Cleland and Mr. W. H. Myers. Amongst the investigations which they propose to carry out in the near future is the application of direct current to the sterilization of ripened cream—a method which was found inapplicable by present methods in the sterilization of milk, owing to the precipitation of casein. This experiment was actually planned, and the cream obtained for carrying it out, when the outbreak of influenza necessitated temporarily abandoning it. Experiments are also being planned for the sterilizing of milk in thin sheets by actinic rays. The apparatus for this experiment has been obtained, but the experiment itself was likewise held up.

WHEAT-BREEDING.

A Special Committee on Seed Improvement, with members in each State, was appointed as an outcome of the Conference of Agricultural Scientists convened by the Advisory Council in November, 1917. The Committee has started work, with head-quarters at the National Herbarium, Melbourne, on preparing standard types of wheat, and a large number of specimens has been sent in from the various States.

A provisional scheme of classification is being used in the work of sorting the material, and its practical value tested in comparing wheats of the same variety from different localities. In addition, comparisons are being made between wheats grown under the same name in different localities, and in some cases striking discrepancies have been noted between similarly-named varieties from different districts, showing the importance of a central office or museum, where wheats from all parts of Australia can be compared and standardized from time to time. In properly-managed Experimental Stations sets of such standards are kept, but at present there is no regular channel by which the standard sets in different parts of Australia can be compared and kept true to type. This is a very important point when scientific breeding is carried on, otherwise, owing to local variations, the appearance of "rogues," &c., hopeless confusion might result when exchanges of seed are made between growers in different localities. Seven standard sets will eventually be prepared by the Special Committee. One set of the leading standards will be sent to the Agricultural Department in

each State, and the remaining complete set will be retained and made available for purposes of comparison and reference by the Institute of Science and Industry.

SHEEP-FLY PEST INVESTIGATIONS.

A report of the New South Wales Committee on the sheep-fly pest, which is financed by the Advisory Council, has been issued in the form of a Bulletin of the New South Wales Department of Agriculture. The Committee is assured that the investigations have been carried out in the right direction, and states that there is every indication that by the general adoption of certain precautionary measures the seriousness of the pest will be considerably minimized and the monetary loss to pastoralists proportionately lessened. The measures referred to are (*a*) the destruction of carcasses and offal, (*b*) the liberal release about pastoral properties of artificially-bred Chalcid wasps, (*c*) the protection of natural enemies, (*d*) the maintenance of the sheeps' health by the regular use of licks where necessary, and finally (*e*) the utilization of the fly-traps which have been perfected by the Committee.

PLASTER OF PARIS FOR DENTAL PURPOSES.

The Institute has taken action with a view to establishing the manufacture in Australia of plaster of Paris for dental purposes. For these purposes the plaster is prepared in several grades, according to the use to which it is to be put, the main uses being (*a*) for making dental casts and models, and (*b*) for taking impressions of the mouth. After consultation with various authorities, the Institute has sent particulars of a specification for the plaster to various manufacturers in the Commonwealth. Two or three of the firms interested are taking the matter up, and have prepared plasters which the Institute is having tested.

CULTIVATION OF TOBACCO IN AUSTRALIA.

The question of extending the cultivation of tobacco in Australia was considered at the Conference of Agricultural Scientists held by the Advisory Council in 1917. The Executive Committee, considering that the questions involved are primarily of an economic and fiscal nature, urged the Commonwealth Board of Trade to take the matter up. As a result of this action, the Australian tobacco companies have offered to purchase, at satisfactory prices, if available, 2,000,000 lbs. weight of Australian-grown, flue-cured tobacco each year for a period of three years, beginning from the date when the first year's product is marketable. It is proposed that, in order to secure the co-operation of the various States, a conference of experts should be called to decide upon the best method of arranging for concerted action. Any experimental work necessary will be carried out under the ægis of the Institute.

PAPER-PULP.

Since the publication last March of Bulletin No. 11, "Paper-Pulp: Possibilities of its Manufacture in Australia," information has been

received by the Advisory Council of tests carried out by the Australian Paper Mills Co. Ltd., South Melbourne, on the pulping qualities of the aerial roots of the pandanus tree, which is reported to be plentiful in the Northern Territory. The results are not encouraging. At a very high chemical cost, the roots can be treated to yield a pulp of a grade sufficiently good to be used in the proportion of, say, 25 per cent. with rag and wood pulp, to produce printing paper of fairly good quality. The yield of air-dry bleached pulp calculated on the air-dry original root is only 29 per cent., which is so low that it is at once apparent that the cost of production per ton of pulp is much too high. The freight over long distances of a bulky material is also against its commercial use.

FLAMMENWERFERN AND PRICKLY PEAR.

A proposal has been made for the destruction of prickly pear by the use of "flammenwerfern." As, however, the water content of the pear is about 90 per cent., and as the weight per acre on heavily infested land is as much as 700 or 800 tons, it would be necessary to evaporate from 630 to 720 tons of water in order to completely destroy the pest. It is not economically practicable to do this with an expensive fuel such as is used in flammenwerfern.

TANKS TO ROLL DOWN PEAR.

Another proposal is to use tanks for destroying the prickly pear on land which is practically impenetrable, but otherwise of relatively high value for agricultural purposes. The authorities in Queensland, who have investigated a large number of proposals for the eradication of the pest, do not favour mechanical methods, compared with chemical or biological treatment. One of the objects in designing tanks is to distribute the load, but to crush and eradicate prickly pear it would rather be desirable to concentrate the load. Moreover, the fuel consumption in tanks runs up to 10 gallons per mile, which means great expense. Steam rollers would be cheaper and more effective than tanks, but these have been tried, and have been proved unsuitable.

MANGROVE TANNING.

These experiments, which are being carried out at Brisbane, are practically completed, a successful method having been evolved for producing a good-quality leather. The Special Committee is now carrying out a series of tests, using tannery methods, and is preparing specimens of finished leather suitable for commercial exhibition. The Committee is drafting its final report, giving detailed methods of working, and this will be published as one of the Institute's Bulletins.

NEW ADDRESS.

Within the last few weeks the Institute has removed its headquarters, which from the first have been at the Inter-State Commission's Office, Albert-street, to Danks' Buildings, Bourke-street, Melbourne. It now shares with the Bureau of Commerce and Industry the floor formerly occupied by the Directorate of Munitions.

EDITORIAL.

The Institute has purchased the botanical portion of Dr. F. Steward's library, which includes a large number of bulletins of the United States Department of Agriculture and a number of French and German scientific works and periodicals.

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The first meeting of the South African Advisory Board of Industry and Science was held at Cape Town, on 14th January.

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A cheque for £350 was recently received by the Rothamsted Experimental Station from the Carnegie Trust for the purchase of important books of reference. When will Australia raise a Carnegie?

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The Canadian Advisory Council of Scientific and Industrial Research has recommended that the existing duty upon alcohol used for industrial purposes be removed.

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Professor Masson, Messrs. A. E. V. Richardson, A. J. McKinstry, and the Director have been appointed a Library Consultation Committee.

Devotion to science is a tacit worship—a tacit recognition of worth in the things studied; and by implication in their cause. It is not a mere lip-homage, but a homage expressed in actions—not a mere professed respect, but a respect proved by the sacrifice of time, thought, and labour.

—**HERBERT SPENCER.**

Applied Science: What it Connotes.

By Sir GERARD MUNTZ.

In works practice in most manufactories there is a regrettable absence of scientific application. The chemist, the metallurgist, the electrician, and the mathematician are, if present at all, relegated to inferior positions, and only allowed to exercise a stultified control. These establishments are managed and run usually by commercial gentlemen having no other practical knowledge than such as they have picked up in casual observation or at second-hand through conversation with managers and foremen.

Many works managers have been promoted from foremanship or clerkship, and from the circumstances of their case have not had opportunities for that extended education which modern business conditions demand. Some of these managers, alas! all too few, have taken the trouble to take up technical study at evening classes, and thereby improve themselves. These are certainly the best men, but after a heavy day's work and long hours what is the state of a man's brain for absorbing and mastering intricate and involved subjects? The available hours are all too short, and he starts too late in life.

The antagonism between the scientist and the ordinary foremen and managers is one of the greatest difficulties which the management of a business has to contend with. Both think that the knowledge the other possesses is of no useful value, but both are wrong. The practical knowledge acquired during long years of works practice is immense and diverse, and can be acquired in no other way. *Experientia docet* is as true to-day as it was 2,000 years ago.

The practical man sees something wrong and knows how to rectify it, though he probably does not know the reasons which cause either the defect or the cure of it; the scientist could possibly in many cases tell him the reasons, though he could not himself do the job, or, as a pure scientist, apply the knowledge which he has to producing something useful. The man who has learnt to apply his science to practical ends is the man needed.

What is the difference between what are commonly known as pure scientist and as applied scientist? Very little really, except that the latter has learnt to use his science for some useful purpose, whereas the former spends his time, in laboratory or study, working out abstruse problems which, if of value, will ultimately be usefully applied elsewhere by his more practical colleagues. What is chiefly needed to-day in British manufacture is the combination of practice and science: at present the men who possess both attributes are lamentably scarce.

Young scientists must be brought in and taught practice, and, on the other hand, as far as possible, the young practical man must be encouraged to take up scientific studies in his own particular branch; he will probably never become a real scientist, but he will obtain a sufficient knowledge to enable him to give intelligent and valuable assistance in carrying out the scientist's ideas and improvements. In practice the scientist will obtain many unlooked-for sidelights from his less educated fellow man. Immense possibilities are to be found in every works from the loyal co-operation of practice and science. Waste products may often be turned into money, processes may be cheapened, quality improved, regularity of grades assured, and innumerable mysteries and vexations cleared up and avoided.

The position of the scientists in the manufacturing world requires reconsideration and regrading. The time is coming when all the best establishments will be managed and controlled by men who have been scientists first and became manufacturers and business men later. The scientific mind is trained on the best lines to produce the best effects in business; habits of method, the power to analyze cause and effect, to look beyond the immediate present, and to seek discovery rather than allow that things are impossible. The tendencies of the age are towards science and progress; the old order and the old ways and the old-fashioned man are passing away. If old England means to hold her own in the new world she must arm herself in the new way to meet the new conditions. Old England and the long bow gave place to English hearts of oak; to-day it is British steel and British pluck which keep things going. To-morrow it must be Imperial Britain's brains plus brawn.

Record of Accomplishment.

Paper from Eucalypts. For the first time in Australia it has been demonstrated that a good quality of paper can be made from Eucalypts. Young karri was used.

Substitute for Tinplate. Many industries were assisted during the war period, when the use of tinplate was prohibited, through the invention of suitable cardboard containers as a substitute.

Utilization of Local Clays. Test pieces and numerical data collected after exhaustive research at the Perth Geological Survey Laboratory are being continuously used by manufacturers in search of clays suitable for their purposes.

Flax Cultivation. As the direct result of cables that passed between the Advisory Council and the Imperial Government, the Flax Committee was formed, and the area under flax has been extended from 400 acres to 1,600 acres, with an expectation of 10,000 acres next season.

Alcohol Engines. Following on the work done on the subject of power alcohol and alcohol engines, a method has been discovered for starting these engines from cold. This has baffled engineers the world over for the last quarter of a century.

Felspar. An eastern State porcelain company has been put in touch with a supply of felspar in Western Australia much freer from iron than that hitherto used.

Tobacco Cultivation. As an outcome of the Agricultural Conference held under the auspices of the Advisory Council last year, the tobacco companies have agreed to take 2,000,000 lbs. of Australian-grown tobacco at a satisfactory price.

Vitrified Earthenware. Heavy losses having been incurred by a Western Australian potter through vitrified ware, local clays were tested and their use eventually recommended, which proved suitable.

Scorifiers. These have been made in Perth from Australian clays and used against the imported article.

The Sparrow Pest. Western Australia is the only part of the Commonwealth that remains free from the sparrow pest. The Institute has taken steps to prevent their travelling westwards along the transcontinental line. They are being shot, and so the western State is being saved thousands a year.

Seger Cones. These were formerly imported, chiefly from Germany and the United States of America. After investigation they are now being made out of Australian clay. Their use is for determining kiln temperatures.

Mechanical Cotton Picker. A machine has been constructed embodying the results of initial laboratory tests, and suitable tractable varieties of cotton have been planted for a large scale test.

Weights and Measures. Steps are being taken with a view to securing uniformity in the regulations throughout the Commonwealth. This is essential for the development of local manufacture of weighing and measuring machines.

Posidonia Fibre. A thorough investigation into the constitution and physical properties of this fibre has been completed. This is a necessary preliminary to developing the commercial utilization of the fibre.

Engineering Standardization. Conferences have been held in each State, and the cordial support of engineers and representative men throughout the Commonwealth has been accorded to the Institute's scheme for the development of engineering standardization.

Road Construction. A large amount of information as to measures taken in other countries for the scientific control of road construction and maintenance has been obtained, and a committee is preparing a scheme for initiating experimental work in Australia.

Grass Tree Resin. A fundamental investigation into the chemical constitution of Grass-tree resin has already resulted in the isolation of several new substances not previously known as a constituent of resin.

Utilization of Kelp. Investigators in Tasmania have succeeded in manufacturing a new product from kelp. It turns perfectly in the lathe, takes on high polish, and is suitable for making insulators, buttons, and various other articles.

Mangrove Tanning. A process for getting rid of the objectionable colour in mangrove tanning has been worked out, and large scale experiments are now being carried out to test the process on an industrial basis.

Sheep-fly Pest. A new parasitic fly which destroys the pupæ of sheep-flies has been discovered in Queensland. Its life history is being worked out, and specimens have been sent to the National Museum, Washington, United States of America, for determination.

The Water Hyacinth. Specimens of this river weed have been obtained and analyzed. The results show that the plant can be used as a source of potash.

Alunite. Methods for obtaining potash-salts from various Australian deposits of alunite have been worked out. If certain important developments now proposed take place, potash from alunite will be available as a fertilizer to be used in the manufacture of artificial manures in Australia.

Paper Pulp. A considerable number of Australian plants has been tested for their pulping qualities. In some cases the results are favorable, in others negative results were obtained.

Wheat-Breeding. Considerable progress has been made in the preparation of standard types of wheat. Striking discrepancies have been noted between similarly-named varieties from different districts. When the standards are complete, all chance of confusion will be obviated.

Sheep-fly Pest in New South Wales. There is every indication that, by the adoption of the precautionary measures worked out and recommended by the Committee, the seriousness of the pest will be considerably minimized, and the monetary loss to pastoralists proportionately diminished.

Defects in Australian Leather. A very large amount of information and expert advice has been obtained on this matter, and steps are being taken with a view to improving the quality of Australian leather.

Life History of Cattle Tick. An exhaustive investigation into the life history of the cattle tick is practically completed.

Scientific Clearing House. The Institute acts as a scientific clearing house. It knows the men, their peculiar qualifications, and it knows where the necessary appliances are. It has already rendered valuable service to several important industries through its special knowledge.

Analyses. Quite a number of analyses have been made of raw materials that promised to have an economic value. This work is proceeding continuously.

Testing Materials for New Uses. Many raw materials of the animal, vegetable, and mineral kingdom have been subject to various tests with a view to ascertaining whether they are of industrial value. Many raw materials have been tested for their pulping qualities for the manufacture of paper-pulp; various minerals have been examined to ascertain whether they can be used commercially for the recovery of potash for fertilizers, colouring matter for paints, &c., and barks of Australian trees have been treated to test their value for tanning purposes.

Publications. The Institute has issued a number of scientific bulletins, pamphlets, and leaflets, which contains a large amount of information not elsewhere obtainable.

Propaganda. The Institute is carrying on a persistent propaganda, the object of which is to turn men's thoughts towards scientific methods. The producer and manufacturer must be taught to realize what science has done for others, and may do for him.

Creation of Atmosphere. It has been part of the duty of the Institute to create a favorable atmosphere for research work among scientists themselves and within the walls of the Universities.

Subsidization. Where scientific work is being efficiently carried out, but is being hampered through want of funds, the Institute has come to the rescue with good results.

Bureau of Information. This has been established and efficiently manned. All manner of information of a scientific and technical character can now be obtained on inquiry.

Scientific Journal. The object of this Journal is to assist in co-ordinating the scientific work being done in the Commonwealth, to prevent overlapping of effort, and to afford an authoritative medium for the interchange of ideas.

Problem Census. Careful inquiries have been made in each State as to technical difficulties affecting the development and progress of existing industries as a whole and of individual firms in particular industries. Information has also been collected regarding opportunities which exist for the establishment of hitherto undeveloped industries, both primary and secondary. This is necessary spade work.

Industrial Census. A large amount of information, partly of a confidential nature, has been collected under this heading, and this should prove of great value in connexion with future work.

Research Work Abroad. All the leading research laboratories of the United Kingdom, the United States of America, and Canada, have been visited, and their organization studied and reported upon by a trusted officer of the Institute. The information thus gained will prove of great value later on.

Co-ordinating Work. By acting as the convener of conferences of scientific men engaged in similar work in different parts of Australia much overlapping of effort has been avoided and greater clarity of vision secured. Several conferences have been held during the past twelve months.

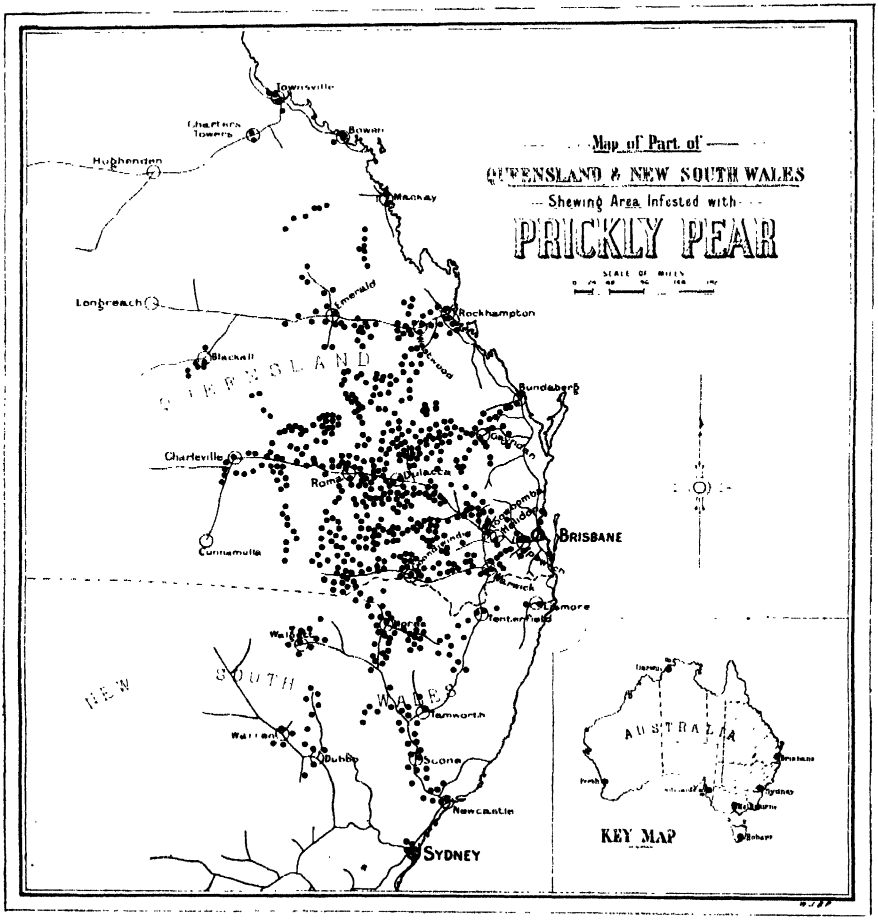
Fountain Head of Authoritative Advice. When Governments, Federal or State, or official bodies require information involving scientific principles, they immediately turn to the Institute. So the Defence Department, the Navy Department, the Government of Papua, the Commonwealth Board of Trade, and the British Board of Trade, have all sought and secured advice.

Useful Negative Work. Not only is positive work useful; negative work is also highly valuable. So the Institute has exploded many wild-cat ideas, has tested many materials, and found them useless for certain purposes, thus avoiding much fruitless work in the future, *e.g.*, proposals to use raw materials for certain purposes, inventions for new methods and processes have been shown to be impracticable.

The Prickly Pear Pest.

By J. BURTON CLELAND, M.D.

The object of this account is not to give a full review of the prickly pear problem either from a land-owner's point of view or from the scientific aspect, but to indicate briefly the position of the matter, and the grave probabilities that must follow a continued course of *laissez faire*, and to sum up what may be expected from various practical and scientific methods of controlling and eradicating the pest. The writer, having been associated with experiments aiming at eradicating prickly pear, and having had the opportunity of talking over the



matter frequently with his colleagues and knowing their opinions, has had opportunities for viewing the problem from points of view not easily accessible to the general observer.

First of all, it must be pointed out that a pest of this nature, though at present practically confined to two States, is pregnant with potential, nay with actual, danger to the other States on the mainland of this continent. Though only the States at present affected are now suffering heavily from a financial

point of view, there is little doubt that the other States will, in the end, suffer similarly unless the problem of control is taken in hand energetically and quickly.

Another point to which attention may be drawn is the regrettable fact that so many of our Australian pests have escaped general notice and official efforts at their control, until they have become so firmly established that eradication is almost impossible and extremely costly. Frequently a plant is not declared a noxious weed until its presence in a locality is so abundant that it cannot be eradicated, whereas had it been exterminated on its first appearance the sum involved would have been quite small.

The present position of the prickly pear problem may be stated to be somewhat as follows:—Millions of acres in Queensland and several millions in New South Wales are covered heavily with prickly pear. Though much of the country so affected is comparatively worthless, many parts are good grazing land, or could be used for other agricultural and pastoral purposes. Besides interfering with the transit of man and animals through the infested country, the prickly pear itself occupies land which should be covered in many instances with

(Photo. supplied by Arthur Temple Clerk, Lands Department, Brisbane.)
PRICKLY PEAR (*Opuntia Inermis*), showing dense Pear in open forest country.

herbage, and instead is covered with this useless plant. Beyond the parts infested heavily or only lightly with prickly pear are extensive areas in which scattered plants occur, perhaps only one to an acre or one to a few square miles. These are the parts which, in a few years, will be densely covered with pear, and it is they that are adding the thousands of acres yearly to what is termed the pear-infested country. There is, in fact, a continued extension of the fastnesses of prickly pear by these outliers extending yearly further and further, thus adding more and more to the financial drag of this vast incubus.

THE PRICKLY PEAR PEST.

It is necessary here to view the means by which these outlying plants of prickly pear reach their various sites, often removed by a considerable distance from pear clumps and heavily infested pear country. A study of such isolated *Opuntia* plants will show that they are frequently found under trees, especially near their bases, and at the foot of posts along fences. Such situations suggest that the seeds have been distributed by birds, and as putting the matter beyond doubt, it may be mentioned that not infrequently prickly pear plants may be actually seen growing from receptacles on the trunks or branches of trees. This question of bird dispersal is one which has hitherto received insufficient atten-

Photo., Dept. Agriculture, Brisbane.

O. monacantha, from Gympie.

tion. We do not know yet for certain all the species of birds that feed upon prickly pear fruits, nor do we know which amongst them are capable of passing the seeds intact through their alimentary canals. We know that the black magpie, *Strepera graculina*, feeds upon prickly pear, because birds have been shot with the fruit in their stomachs and the vents much stained by the purple juice. It is necessary to know for certain whether the seeds can germinate when passed in the excrement of this species. Even supposing the seeds are, under these circumstances, capable of growing, the bird must not be condemned offhand, for it may be that it possesses other good qualities which more than

compensate for the dispersal of the prickly pear seeds. There seems little evidence as yet in New South Wales incriminating other birds that fly, but it is frequently stated, and on good grounds, that the emu is an efficient means of dispersal. Emu droppings frequently contain the seeds. Their powerful build enables them to overcome, to some extent, their handicap in not being able to fly, so that they may pass from paddock to paddock by getting through fences. The part that the emu may play in the problem is, however, one that must be scientifically investigated with care and thoroughness before the bird can be condemned. In some districts the aborigines are said to feed freely on prickly pear. Statements have been made that prickly pear plants frequently grow up where these persons have defæcated behind trees. Care should be taken in sifting such evidence, and experiments planned to prove or disprove this possible minor factor in the spread. When prickly pear plants grow along watercourses, be they

WILD COCHINEAL (*Coccus confusus Newsteadi—on Nopalea cochinelifera*), Antigua, West Indies.

low banks liable to flooding, or rocky gorges, the flood waters may dislodge segments of prickly pear, and distribute them lower down in their courses, thus heavily inseminating possibly hitherto unaffected areas. Some of the exceedingly prickly species of *Opuntia*, fortunately of kinds at present locally circumscribed, have joints so easily detached and spines so arranged that the segments themselves might easily be transmitted over considerable distances by quadrupeds. Such a means of spread of this pest, however, cannot be considered as playing any important part in its wide dispersal.

The increasing density of pear, in areas where considerable infestation already exists, is due partly, of course, to the means already indicated, but chiefly to direct extension in size of the original plants and the breaking off of segments

by many varied means in their neighbourhood, as most of these segments will eventually take root and grow, and to the distribution around of the fruits. It can be quite understood how rapidly a lightly infested area becomes heavily infested, and the heavily infested almost ineradicably so.

Let us now consider the question of eradicating prickly pear from infested areas. It is not proposed to go into this aspect fully. The means by which it can be eradicated will merely be briefly indicated. At the present time these methods may be placed under three headings—mechanical eradication; eradication by chemical methods; and eradication by biological methods.

Mechanical methods employed comprise cutting out or dragging out, followed by stacking and burning, and crushing by means of heavy logs or rollers. Various suggestions have been made which comprise in principle one or other of these methods. In this connexion may be mentioned the possibility of destruction by fire blasts, the heat employed causing rupture of the epidermis by the steam generated in the juicy parts of the leaf, besides scorching the dormant buds.

The chemical methods of destruction on a large and practical scale so far consist in spraying with preparations containing arsenic, the segment being frequently injured by the application at the same time of some caustic or escarotic such as sulphuric or hydrochloric acids or caustic soda. Destruction by means of gaseous fumes has, of course, been thought of, but no entirely satisfactory practical method has as yet evolved.

The biological methods of control are represented at present by the use of a cochineal insect, which has been found successful as regards one species of *Opuntia*, but, unfortunately, not against the most widespread species of the pest here. There is also the possibility that some fungoid or bacterial disease may be discovered which may be destructive to prickly pear.

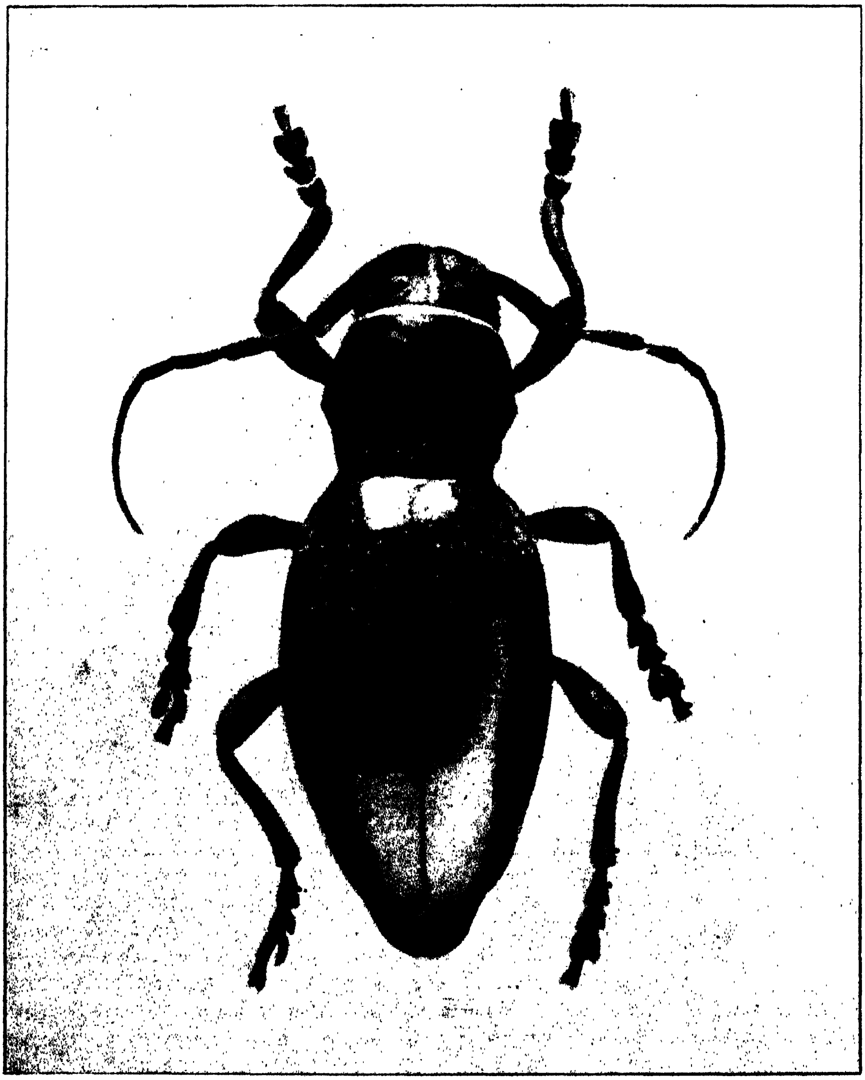
Here it may be mentioned that in all the methods hitherto tried for the eradication of prickly pear expense is heavy, and particular care is essential. Frequently the cost of eradication approximates to the value of the land to be cleared. In many parts no attempt at getting rid of prickly pear has been made because the cost of eradication would be much greater than the value of the land reclaimed. It may be further added that great hopes cannot be held out that scientific endeavour, even by the ablest and most experienced of men, will discover an easy and rapid method of prickly pear destruction. There is a popular idea that there is a remedy for every evil under the sun. Those who have had experience of the control of pests and of disease know that such is by no means the case. It is true that there are not a few diseases and pests which can, apparently by accidental and fortuitous circumstance, be easily and cheaply controlled. In the great majority of cases, however, the control requires continued and unremitting toil, constant care, and outstanding common sense.

The present position of the prickly pear problem will be seen from the above remarks to boil itself down to this: That there are great areas of prickly pear in two of our States which are yearly extending and becoming more aggressive, and that no means have yet been discovered, or are likely to be found out in the immediate future, by which the areas at present infested can be cleared of prickly pear at a trifling cost. What, then, should be done under these circumstances? It is obviously absolutely imperative to arrest the further progress and to beat back the prickly pear as rapidly and as quickly as possible.

The following may be suggested as a basis for fuller discussion:—

I. Assessment of the Distribution of Prickly Pear.—Though to a considerable extent this is known, and data have been compiled from which the distribution of severely infested and clean country can be ascertained, it is very necessary

that much fuller knowledge should be obtained. This could probably be achieved by requiring the notification of all land infested by prickly pear, with an estimate of the degree of infestation divided respectively into "ineradicable prickly pear," "heavily infested with prickly pear," "lightly infested with prickly pear," and "scattered infestation." In the first category would appear infestation where the cost of eradication would be far greater than the value of the land reclaimed. Heavy infestation would mean that though the cost of destruction was considerable, it would still be under the value of the land. Under light infestation would be placed country where the cost of eradication would



A CACTUS LONGICORN BEETLE—*Moneilema crassum*—which, in Texas, feeds on the joints of cacti, the larva destroying the internal tissues of the attacked plant. (From "The Principal Cactus Insects of the U.S.A.," Bulletin 113, Bur. Entomol, U.S.D.A., 1912, plate 1.)

be an appreciable amount per acre, but much less than the value of the land; whilst scattered infestation would apply to parts where there were only one or two plants of prickly pear to an acre or perhaps a square mile, and the cost of eradication would be very small per acre.

It would be necessary before notification could be required to define more clearly these various types of pear country, so as to afford a guide to landholders in describing the infestation on their property. The basis for such definition could rest either on the amount of land surface covered by prickly pear, which would be suitable for the higher grade of infestation, or on the number of plants per acre which would apply to the lower grades. Another feature for consideration would, of course, be the big variations in the degree of infestation within quite a limited area. The main object of the notification would be to ascertain the limits of the pear-infested country, and especially of those parts where prickly pear is only just appearing. Where the prickly

Photo., Dept. Agriculture, Brisbane.

Flowers and developing fruit of the Spiny Pest Pear, from Gracemere.

pear infestation is scattered it could be no hardship to any one, and it is an absolute necessity in the interests of all, to have that pear eradicated before it extends further. The owners of land have under this suggestion an opportunity of describing the degree of infestation on their property, and on those places in which the infestation is described as scattered should then be required, under reasonable conditions, to eliminate the pear from these parts. Supposing, to avoid this requirement, the land was classified as belonging to a higher scale of infestation, this could be covered by later inspection, when, if it was shown that a deliberate mistake had been made in making the return, measures might be taken to deal with the matter according to the circumstances of the case. Supposing by inspection prickly pear is found on property in scattered amounts,

and has not been notified, a fine could justifiably be inflicted. Having in this way attempted to prevent the further extension of prickly pear areas by eliminating "scattered infestation," lightly infested areas of the pear known by notification could then be systematically attacked by various approved methods, land-owners being required perhaps to prevent these lightly infested parts from becoming heavily infested, and annually to reduce the area of light infestation by a certain amount. Eventually, in the course of time, the prickly pear would be reduced to a number of isolated strongholds or "islands" of "heavily infested" and "ineradicable" pear country. These, as time went on, could be gradually reduced further and further, working from the periphery, whilst proper precautions would prevent reinfestation of the previously cleared country. Difficulties are sure to rise as regards notification on Crown lands and roads. It is as essential that these should be controlled as that private holdings should be dealt with. Land-holders should be encouraged to notify the occurrence and degree of infestation of prickly pear on Crown lands and roads, so as to aid the Government officers in ascertaining its distribution in these parts.

The object of this notification will be seen to be primarily to ascertain what parts of their property land-owners consider to be infested with scattered pear only, and then to bring about the destruction of that scattered pear before the infestation becomes greater, and thus to hold the advance of prickly pear in check.

The Forestry Commission or the Forestry offices in the various States may be able to play a very important part in the control of prickly pear, especially when it is remembered that considerable sums are obtained by them as royalties which could not be better expended in part than in attacking this pest.

II. Scientific Investigations.—Though great hopes of a royal road for dealing with the prickly pear cannot be held out, there is not the slightest question that well-directed efforts along scientific channels will be of enormous help in dealing with the problem. Here too great emphasis cannot be laid upon the value of team work in any inquiry such as this. By team work is meant that no one single scientific worker should be shouldered with the responsibility of finding out all that is required, but that a battery of the ablest men available should be brought into association with the problems to be solved and work out a number of collateral methods of attack. As regards the prickly pear, we require not only botanists (both systematic and biological), entomologists and chemists, but engineers, mechanicians, agriculturists, physicists, and general biologists. We want, in fact, the various problems attacked from every conceivable aspect by the ablest men we possess, and we want to give these men an opportunity of actually viewing the growing pear and seeing for themselves what has to be done. We may briefly indicate some of the lines that may be followed up with advantage as follows:—

(*a*) Microscopic examination of the prickly pear with the object of ascertaining the most vulnerable means of attacking it.

(*b*) Circumstances under which the seeds of prickly pear germinate, this being specially worked out in association with ornithologists who have suggested the supposed distribution of the prickly pear by birds.

(*c*) Search for fungoid and bacterial diseases of the prickly pear.

(*d*) Further consideration of insect destroyers of the prickly pear, and especially attempts to establish strains of the cochineal insect on the most prevalent pest pear.

(e) Chemical means of destroying the pear by spraying or other means.

(f) Mechanical means of destroying the pear and the relative cost of these. Under this heading would be included not only the actual method but experiments with various designs of machinery and apparatus for dealing with the pear. Also included under this heading may come more perfect designs for sprays for applying chemical agents. The possible destruction of prickly pear by fire blasts may well be considered, especially by oil blasts such as are used in engineering workshops for melting metal.

(g) Attempts to find a use for prickly pear in some way. Alcohol, fibre, and ash have all been thought of, but no practical method has as yet been evolved for successfully utilizing the pear for these purposes. It is possible that further endeavour may devise some means by which the cost of eradication can be lessened, to some extent, by some product being an off-set, and bringing in some return.

We may conclude by stating in the most emphatic terms possible that it is absolutely essential, in the general interest, that the further progress of prickly pear should be immediately checked. Notification wtih an estimation of the degree of infestation seems advisable to enable this check to be imposed. All scattered pear should be immediately eradicated, and this can be done at trifling cost. A battery of scientific workers should be directed to attacking and overcoming the various scientific problems that are calling for prompt investigation and settlement.

Nothing great in science has ever been done by men, whatever their powers, in whom the divine afflatus of the truth-seeker was wanting.

—*HUXLEY.*

Technical Education.

By G. D. DELPRAT, C.B.E.

The question of education is not one which has been specially recommended to us*, and may be considered to be outside of the indicated scope of activities of the Institute, but during the period the Institute of Science and Industry has been at work, it has gradually become very clear to me that, unless the system of education in Australia is radically changed, and a better system substituted, the labours of the Institute will, for the greater part, be thrown away.

We may be able to start new industries, and may assist some of those that are now in existence, but this is not sufficient to attain the object in view. I start from the position that, when the military war is over, we will enter into an industrial war, one more prolonged, more bitter, and without mercy; that the nation best equipped to fight in this war will conquer; that no legislation can make an inefficiently equipped nation conquer an industrially efficiently equipped nation, and that no legislation can turn aside the fate of the vanquished. In other words, that commercial and industrial supremacy will, without any doubt, come to the nation best equipped for this industrial war.

If this be true, it is incumbent on us to take such steps as will secure our nation the most modern equipment—mentally—that can be obtained—as good as the best, and nothing less—and this in the shortest time possible. A stern chase is a long one. The further a competitor gets ahead, the more difficult it will be to overtake him.

Even at the risk of being politely told to "mind our own business," I think our Executive (if it agrees with me) should draw the attention of the Federal Government to this question. I know that frequently steps have been taken to improve our educational system, and that many improvements have been introduced. I am convinced that our educational system includes many valuable units, but it is not an improvement of existing educational units, which I wish to bring before the executive—my proposal is of a much more drastic nature.

What I propose is that, first of all, we should consider what is the highest standard of scientific efficiency it is considered desirable to attain, and this first step should offer no difficulties. The standard to be reached is, of course, at least the highest standard reached by any of our rivals. We know then the level we want to reach. The next step is to trace the best road to reach this point, having no regard for anything but the object in view.

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* The Institute of Science and Industry Bill, however, provides, see section 14:—

The Governor-General may arrange with the Governor of any State for any of the following purposes:—

(a) The utilization for the purposes of this Act of State Research Departments and Laboratories and Experimental Stations and Farms;

(b) the co-operation in industrial and scientific research with State Government Departments, Universities and Technical Schools; and

(c) the co-operation with educational authorities and scientific societies in the Commonwealth, with a view to—

(i) advancing the teaching of science in schools, technical colleges, and universities, where the teaching is determined by those authorities;

(ii) the training of investigators in pure and applied science and of technical experts; and

(iii) the training and education of craftsmen and skilled artisans.

In order to do this, we should first of all send one or two eminent men to each of those countries in Europe and America, where we think valuable information, based on actual results, could be obtained, so as to benefit by their experience.

We should then trace a trunk line of education which will represent the progress of the mental development of the child, right from the time he leaves the A B C to the time he leaves the University. It is clear that every individual will not wish to follow this trunk line from beginning to end. There will be several stations along the line where side lines will have to branch off into fields of special knowledge; where the engineer will branch off to get his special teaching; others where the chemist will go off into his special field; and others, again, where the medical man will seek his own preserve. There will be points where the scientific education of the labourer is completed, and others where the skilled artisan goes to his special school, and again other points where the commercial man will consider he has learned sufficient to go into business. In fact, all people will travel along the road until they arrive either at their destination, or reach a point where they branch off into their own speciality.

The main idea is that the scheme of education, as laid down, shall not be a compromise, so as to avail ourselves of the units now in existence, but a scheme thought out independently as the best to answer its purpose, irrespective of existing educational machinery.

The next step should, therefore, be to place alongside of this educational scheme a list of all existing educational establishments; to pick out from amongst these and insert those that fit exactly; to pick out and modify those that can be made a perfect fit by such modification and to scrap those that cannot be made such a perfect fit.

The educational system is necessarily a piece of very complicated machinery. In no modern machine would a constructor put in a cog wheel just because it happened to be lying about, unless it were exactly of the dimensions, character, and material required. No engineer would dream of such a thing. The same should hold good of the educational machine. Only if the machine be built in the most perfect way can it attain its object of giving the best results possible to be attained. No compromise is possible to make the machine different, on the plea of cheapening its construction. It must fulfil its object, and unless it does this, it is wasting money to build it at all. Only when the machine is perfect can the highest results be obtained, and nothing less than the highest results are of any good, as only the highest results offer a guarantee to our not being left hopelessly behind in the industrial race.

I am not blind to the many objections against this scheme, and the difficulties in carrying it out. They are very many, the principal being the cost and the fact that education in Australia is in the hands of the States; but where so many thousands of lives have been lost, and so many millions of money spent to secure for our nation its national freedom, these difficulties should not be allowed to stand in the way.

We have spent several hundred million pounds in equipping our men to obtain a winning position on the battlefields of France. Let us now spend a few more millions in equipping our nation mentally, in order to conquer a winning position on the battlefields of industry

and commerce. This money will be the best-paying investment ever made. It would be criminal to allow all these sacrifices to have been made in vain, and this would be the case if we could not hold our own industrially against our rivals, with the result that we fall a prey to the industrial aggressor.

Our place amongst the civilized nations of the world will, in the long run, be exactly the place we occupy on the educational ladder, and no legislation—however ingenious—can alter this fact. It is the law of nature that the mentally weak falls a prey to the mentally strong, with individuals just as with nations. I think, therefore, that this radical treatment of the educational system is absolutely necessary, and that nothing less will do. Further, that this is the time to bring it forward. We must prepare for the industrial war now the present war is over.

The great importance of this matter should, I hope, be sufficient justification for our overstepping the strict boundaries of our duties, if such be the case, and if the Executive agree with my ideas, I would suggest that the Government be approached in such a way as the Executive considers most advisable.

I do not wish to draw attention to the various imperfections of our present educational system. I am afraid I would not be competent to do so properly, but if my suggestion of sending men to foreign countries to study their systems is carried out, on their return they would be able to speak with great authority. It may not be amiss, however, to draw attention to one or two points which strike me most: First, that students enter our Universities when their scientific education is not sufficiently advanced. The result is that the first one or two years at the University are used by teaching the student what he already ought to have known before entering, and that, therefore, the available useful time at the University is curtailed by this period. All secondary schools should be under strict Government control, so that pupils leave these schools with the same standard of knowledge—and that standard a good deal higher than at present—so that on entering the University, should they do so, the University teaching can begin at once, without the necessity of teaching first principles. The matriculation examination should be a much higher standard.

Another objection I have to the present system is that boys leave the primary schools at about fourteen years. They only enter their apprenticeship—if they go in for this—at sixteen. The two intervening years they spend anyhow—mostly in the street, learning what they need not know, and not only forgetting what they have learnt, but also losing the habit of learning. When they enter their apprenticeship, they have facilities for attending excellent evening classes; but it is astonishing how few avail themselves of these, and how few—after they have joined these science classes—continue to attend. The reason is that they have lost all habit of acquiring learning, and know so little that they join the great number of badly educated men, who look down on a scientific training. The result is a lack of knowledge and trained reasoning amongst the working classes, which is a calamity.

The want of unification in Australia is further a great drawback. All schools should be built on the same model—the best model—so

that a boy from a class in one State in a certain school should be able to transfer to a similar class in any other school in any of the other States. Teachers should be highly-paid men—highly trained, but not only trained in science, but in the science of teaching, and no man, however high his scientific attainments are, should be allowed to teach in any school, or direct such a school, without having first properly qualified in the science of teaching.

A man may be an eminent doctor or scientist, or clergyman, but may be utterly out of place as a teacher, and a lady may be a most deserving widow in reduced circumstancees, without being a qualified teacher. Teaching makes or breaks a child's future, and it is a crime to intrust this to unskilled persons. This applies only to schools, not to Universities.

During my work I have come into contact with many scientifically trained men from various countries, and have had many such men of various nationalities working with me. I have no hesitation in saying that, generally, the British and Australians had the poorest scientific equipment of any of them. But I must qualify this remark by another. Notwithstanding his poorer scientific equipment, I found almost invariably that the man from British stock was the most useful, energetic, and reliable, and these qualities outweighed their lack of knowledge to such an extent that I came to the conclusion—get a Britisher every time. This being so, how much superior would the Britisher be if he were not handicapped by insufficient scientific training. My firm opinion is that, train the Britisher properly, no other nation will be able to beat him. In order to avoid any misapprehension, I wish to point out that my remarks only apply to the large bulk of the population. There are eminent men of science in the Empire, as eminent as any that can be found anywhere—perhaps even more so. These men would probably have been eminent under any system of education. Eminent men come out of our universities and hold their own anywhere in the world. I am not discussing these. I am only advocating a better system of education for the average man, so that the average standard of efficiency should be raised. I do not wish to pose as an expert in education. I am not. I am only giving my impressions from my experience in many countries and association with scientific men of various nationalities. I hold that a highly skilled body of teachers is the most valuable asset a nation can possess. They form the building material out of which the structure of the nation is built. If the plastic material supplied by the Australian mothers is badly moulded and made into defective bricks—if the structural timber is badly seasoned—if the steel is badly rolled—the structure can only be a defective one, and no ingenuity on the part of the Government can make it first class.

The teachers of our young manhood, who form this building material of our social structure, are, in my opinion, the most important section of our community, and no trouble or expense ought to be spared in drawing into this body the men with the brightest brains and biggest hearts—men who teach not only scientific truths, but moral truths.

Once the first class building material is obtained from our unequalled resources, the task of the legislators would be a comparatively easy one, but without this material it is an almost impossible one.

Obligation of Science to the Pastoral Industry.

By Professor JOHN W. PATERSON. B.Sc., Ph.D., F.H.A.S.

Of the various problems awaiting investigation at the present time, there are none of greater interest, none of more economic importance, than those pertaining to the pastoral industry. From figures supplied by the Commonwealth Statistician, the pastoral industry, in its various branches, occupies a leading position in the Australian production of wealth, and yields a revenue which is approximately equal to that from all the manufacturing industries put together. The position will be gleaned from the following statement, calculated from official estimates, which are given as "substantially correct":—

The large circle represents £50,000,000, the small black area £104,166, the sum which would be available annually if ½d. in the pound were set aside for research.

AVERAGE ANNUAL PRODUCTION FROM INDUSTRIES IN AUSTRALIA during quinquennium 1909-1913:—

Item.	Industry.	Value.	Percentage of Total Production.
		£	
1	Agriculture	42,300,000	21·7
2	Pastoral	53,613,000	27·5
3	Dairy, Poultry, and Bee Farming ..	18,436,000	9·5
4	Forestry and Fisheries	5,550,000	2·8
5	Mining	24,234,000	12·4
6	Manufacturing	50,937,000	26·1
	Total	195,070,000	100·0

The period taken for comparison is that immediately preceding the war, and the figures indicate gross returns from the different industries. When it is noted that the labour involved in pastoral production is less than in any other branch of industry, it becomes apparent that improved methods here will in an especial measure go to enhance the national income.

Pastoral, **27 per cent.** *Manufacturing,* **23 per cent.** *Agriculture,* **21 per cent.** *Mining,* **12 per cent.** *Dairying,* **9 per cent.** *Forestry or Fisheries,* **2¾ per cent.**

Of the total production in the pastoral industry, the major portion, as one would expect, is exported to other countries. In 1913 the value of these exports amounted to £41,436,861, which was equal to just over 52 per cent. of the aggre-

Total Exports from Australia

Pastoral, 53 per cent. *All other, 48 per cent.*

gate value of all exports from Australia in the same year. The following table indicates (*a*) the nature of the chief pastoral products exported, (*b*) their values, and (*c*) their values in terms per cent. of the total pastoral exports for the year:—

NATURE AND VALUE OF THE PRINCIPAL PASTORAL PRODUCTS EXPORTED FROM AUSTRALIA IN 1913.

Exports.	Value.	
	Actual.	As Percentage of Pastoral Exports.
	£	
All Pastoral Exports	41,436,861	100
Including—		
Frozen Beef	2,652,144	6·4
Frozen Mutton and Lamb	2,896,292	7·0
Tinned and Potted Meat, &c.	1,266,030	3·1
Tallow	2,157,610	5·2
Hides	1,418,191	3·4
Sheep Skins	2,480,900	6·0
Wool	26,268,214	63·4

The items enumerated here made up nearly 95 per cent. of the total pastoral exports, and the figures indicate their relative importance. Looking further into details, it is apparent that sheep products formed about 80 per cent. of the total, and of these wool formed by far the largest item. Wool, indeed, forms Australia's chief export, and it is clearly one of those commodities for which she possesses superior natural advantages in production when it comes to competing with the staple product on the markets of the world. No other country has ever carried an equal number of sheep.

SCIENCE AND INDUSTRY.

The following table shows the number of live stock in the Commonwealth at decennial periods since 1860, from which date fairly complete figures are available, and for 1916:—

NUMBERS OF LIVE STOCK IN COMMONWEALTH.

Year.	Horses.	Cattle.	Sheep.	Pigs.
1860	431,525	3,957,915	20,135,286	351,096
1870	716,772	4,276,326	41,593,612	543,388
1880	1,061,078	7,523,000	62,176,027	815,776
1890	1,521,588	10,299,913	97,881,221	891,138
1900	1,609,654	8,640,225	70,602,995	950,349
1910	2,165,866	11,744,714	92,047,015	1,025,850
1916	2,437,157	10,459,237	76,668,604	1,006,763

Within the period, horses and pigs show a fairly steady increase—the latter, however, scarcely belong to pastoral farming in the ordinary sense. Of chief importance are the data concerning sheep and cattle. Both classes of stock naturally show large increases over the whole period, but the numbers have been subject to considerable fluctuation in later years, chiefly owing to droughts. Generally speaking, it may be said that the year 1890 registered high-water mark in numbers of live stock under initial methods of pastoral farming. Up till that year larger areas of suitable lands had been gradually brought under the care of the pastoralist, and the numbers of live stock had correspondingly increased. But the fluctuating decline in cattle, and more particularly in sheep, during the last twenty-six years, shows that the original source of increment has been exhausted. The limit of production under the older extensive methods has been reached, or nearly reached; the best grazing lands are already in occupation, and it is evident, therefore, that if we are to further increase or even maintain our stock-carrying capacity, recourse must now be made to more scientific methods and more intensive systems of management.

In its various phases the pastoral industry presents many important problems for investigation. These cover a wide field, and may be arranged under six headings, viz., problems concerning—

1. Soils and manures.
2. Seeds and herbage.
3. Food requirements of stock.
4. Breeds and breeding of stock.
5. Control of pests and diseases.
6. Storage and marketing of produce.

It is possible here to mention only some of the many important points awaiting attention under the above headings.

SOILS AND MANURES.

Classification and study of soils according to climatic environment, physical properties, and chemical composition, more especially in regard to phosphates and carbonate of lime. Investigation of poor returns from certain lands, ameliorative treatments, especially by liming, manuring, cultivation, and drainage. The restrictive action of specific forest vegetation on pastoral vegetation; plant toxins. The utilization of native phosphates, lime, potash, artificial nitrogen fertilizers, and accurate financial records of their continued use.

SEEDS AND HERBAGE.

Identification, classification, description, and habits of indigenous and exotic pasture plants. Search for new species in foreign lands; acclimatization work. Formation, maintenance, and renovation of pastures; effect of over-stocking, and treatment upon botanical composition of pastures. Weeds, poison plants, and their eradication.

OBLIGATION OF SCIENCE TO THE PASTORAL INDUSTRY.

FOOD REQUIREMENTS OF STOCK.

For maintenance and for production. Fodder conservation—provision for droughts. Relative importance of soil fertility and plant species in determining feeding value of pastures. Mineral nutrition and the adequacy of proteins from different sources. Commercial results of hand-feeding during limited periods.

BREEDS AND BREEDING.

Relative suitability of different breeds and their crosses for specific purposes. Fundamental principles of breeding. Care of breeding stock and diminution of breeding losses. Breed records. (It is to problems arising under this heading that the practical man and the agricultural society have almost exclusively given attention.)

PESTS AND DISEASES.

Investigation of stock diseases in regard to causes, symptoms, and control. The work awaiting attention forms a large and most important field of inquiry, and would deal with such vital matters as blow-fly, cattle tick, worm nodule, and tuberculosis, all of which cause enormous animal loss.

STORAGE AND MARKETING.

Problems in canning, freezing, prepared articles, wool scouring, shipping facilities. Co-operative buying and selling, tariffs, and foreign propaganda by Australian agents. Market reports.

The future development of the pastoral industry will depend upon its knowledge of those various subjects, and the enterprise and judgment with which it puts that knowledge into practice. Under these circumstances, it is evident that an organized campaign of research and publicity work concerning the pastoral industry must be instituted as a matter of national obligation.

In considering this matter, it is necessary to maintain a due sense of proportion. We have already noted that the annual pastoral production of Australia exceeds £50,000,000, and an expenditure of only ½d. per £1 on this sum would provide a sum amounting to £104,166 each year for systematic investigation of its problems and the dissemination of existing knowledge. As is well known, other countries are spending large amounts on agricultural education and research, *e.g.*, the national bill of the United States of America on this account exceeds £12,000,000 per annum. It is not a question of whether our pastoral industry can afford to spend large sums in elucidating its many problems and in standardizing its needs; it is a national question to decide rather whether it can afford to do anything else.

Freedom for Research.*

By E. J. RUSSELL, D.Sc.

I have gone carefully into the published details of the scheme for the foundation of a Commonwealth Institute of Science and Industry, and have much pleasure in forwarding to you the following suggestions.

In the first place, I think the general idea is admirable, and if successful will, I have no doubt whatsoever, fully come up to expectations not only in increasing productivity and powerfully stimulating educational institutions, but also as you say it will "go far to inaugurate a new era in the economic and industrial life of the Commonwealth."

There are a few of the details I should like to discuss.

Speaking generally, the work of the Institute falls under two heads: getting knowledge, and using it. Now all experience shows that this requires two very distinct types of men, neither of whom will allow that the other is his equal. The man who gets new knowledge is commonly studious, rather sceptically minded, and obstinate; he does not believe in the accepted explanation of things, and so sets about trying to find some other. On the other hand, the man who applies knowledge successfully is more a man of the world, less given to the study of abstract matters, but with a wider knowledge of the requirements of the community. Each is really dependent on the other, but each will insist on working independently, or else endless friction may result. The atmosphere of research has to be one of absolute freedom to think and speak as a man believes.

Now a large central institution dominated by one or two men tends rather to get into official grooves. Views become stereotyped, matters are looked upon as settled because some one at the head of affairs worked them out when he was younger, and definite lines gradually become laid down along which subsequent work tends to proceed. The ordinary science student may be quite content with this, and considerable useful work may result. But the real research man who wants to test this thing and that thing, which everybody about the place has always accepted, tends to be looked upon as a bit of a nuisance. And yet perhaps in his testing of long cherished opinions he might strike some new idea of first-rate importance.

I am strongly of opinion that the research man will flourish best in a free atmosphere.

The question then arises: How is this to be attained?

For the reasons just given I do not think that it is possible, even with the best will in the world, if the research is concentrated in one institution.

On the other hand, it is obviously impracticable to give every individual researcher his own show; you must have some degree of working together.

* This interesting communication was not written for publication. It is, however, an interesting and valuable opinion from Dr. E. J. Russell, the Director of the famous Rothamstead Experimental Station.

And there, I think, is the best solution of the problem.

I suggest that the aim should be to encourage research in a number of institutions, rather than to concentrate it in one.

Further, that no rigid bonds should exist between these institutions, and that they should not be controlled or administered from any central place.

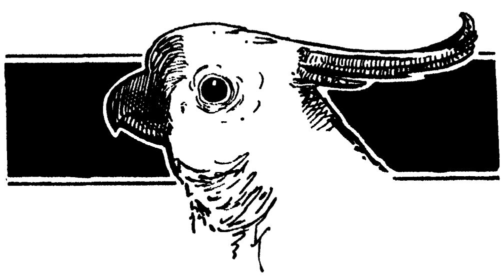
While it would be necessary to take steps to prevent excessive overlapping, it is equally necessary to have a certain amount, so as to insure adequate criticism of results and to maintain a healthy spirit of emulation and scientific controversy.

I think the best sort of connexion between them would be some sort of council, on which each would be represented, presided over by some distinguished Australian whom all would respect.

No doubt you will get many expressions of opinion. I send you this in the hope that it may not be altogether without value. I hope the scheme matures, because I have already said I think it is a very good one.

Science is, I believe, nothing but trained and organized common sense differing from the latter only as a veteran may differ from a raw recruit; and its methods differ from those of common sense only so far as the guardsman's cut and thrust differ from the manner in which a savage wields his club.

—HUXLEY.



Applications of Veterinary Research: With an Example.

By Prof. HAROLD A. WOODRUFF.

(1)

The applications of science to industry are legion, and among them the one which brings knowledge of the causes, methods of treatment, and prevention of the diseases of stock, must clearly be of considerable importance to the Australian stock-owner. Australia owes more than she knows to the applications of veterinary science, and yet she is suffering immense losses in the stock industry which scientific research might be expected to mitigate or prevent.

The geographical position of Australia has undoubtedly materially lessened the incoming of animal disease, for importation of animals has been expensive, and so has been confined to carefully nurtured and healthy pedigree stock. Furthermore, the time interval between the last port of call and the first Australian port exceeds the incubation period of nearly all the great animal plagues, so that an outbreak of disease, and probably some deaths, are bound to occur on the ship if the infection was introduced in animals taken on at any foreign port.

Again, for many years now effective quarantine, at first by the State, and later by the Commonwealth authorities, has been a powerful factor in keeping out infective diseases. But perhaps the most important protection has been the freedom of the stock of Great Britain and Ireland—the stock from which most of our imported animals have come—from those animal plagues which have ravaged many other countries. In other words, the application of veterinary science in the United Kingdom has had effects of great importance in Australia.

Thus it comes about that Australia is free from such diseases as Glanders in horses, Foot and Mouth Disease of ruminants, Rinderpest or Cattle-plague, and Rabies or Hydrophobia of the dog. Parenthetically it may be mentioned that the last three of these diseases are non-existent in the United Kingdom, and the first is decidedly rare and easily guarded against by special means. But, assuming that a large number of animals were being imported from different countries, the danger of introducing any of these diseases would be of a different degree, in each case.

Glanders is a slow insidious disease, taking months or years to develop so as to be obvious clinically. Thus a horse apparently in perfectly good health on leaving Europe might have the latent infection of glanders. No symptoms need develop during the voyage, but months after arriving in Australia the evidence might be manifest. Nevertheless the danger of importing glanders is comparatively small, for by means of special biological tests its detection in the earliest stages is almost infallible.

Rabies is in quite a different category, for here is a disease usually quite acute, and with an incubation period of about three weeks as a rule. One of the mysteries of the disease, however, is that this usual incubation may be greatly extended, and cases are recorded where the interval between infection—as after a bite from a rabid dog—and the development of symptoms has been as much as twelve months. Until the symptoms are shown, there is no known method of diagnosis, and so a real danger exists, only to be overcome by preventing all importation of dogs from countries where the disease is known to occur, and imposing a long quarantine on dogs even from clean countries.

Rinderpest and Foot and Mouth Disease belong to still another class. They are acute febrile diseases markedly infectious, and with short incubation periods of only a few days. Importation of a number of cattle, pigs, or sheep into Australia could only introduce either of these diseases if there were no port veterinary inspection and no quarantine. The disease in either case must have declared itself during the voyage from the last port of call, and cases would be certainly seen in the quarantine station. An analogy suggests itself in connexion with the relative chances of introducing Spanish influenza and tuberculosis of man from Europe, Africa, and America. The former disease has a very short incubation period, and cables from the last port or wireless from the ship can prepare the health authorities. Tuberculosis may be dormant and unsuspected for years, so that even a searching medical examination of every person coming to Australian shores, followed by a month in quarantine, would not serve to exclude tuberculosis. Now this leads up to the statement that diseases of slow insidious origin, with a long incubation period, are much more difficult to keep out than the acute infective fevers. This is true of animal diseases as well as human, and it is just as true of the individual farm or station introducing new stock from without as of an isolated country importing stock from abroad. As an example, we may consider the disease known as contagious abortion of cows.

Contagious Abortion of Cows is a disease of considerable economic importance because of the great losses which result from it. It is prevalent in nearly every country in the world, and has been the subject of much inquiry and research in Great Britain, Denmark, the United States, France, and Germany. This disease has a wide distribution in Australia, and it is a matter of grave concern to dairy farmers in all the States. It entails great losses, not because of a high mortality among the affected cows, for, in fact, it is not a fatal disease, but rather because many of the infected cows abort, and so fail to come to their normal milk yield; that there is great loss of calves; and further that a considerable number of infected cows become sterile, and so cease to be of use in the dairy herd.

The disease is most insidious in its onset, for, apart from the act of abortion, which occurs only in a minority of the animals affected, and then usually only several months after infection, there are no symptoms. Thus in importing pedigree cows from abroad it has been possible to import this disease without any one—either the foreign owner or the purchaser—being aware of the fact. Even if an abortion occurred during the voyage, it would usually be put down to the weather or conditions on shipboard, and so the disease has been introduced into Australia, one may confidently assert, again and again.

Similarly, a dairy farmer may sell an infected cow in a market, she may be bought by another dairy farmer, both buyer and seller being unaware of the fact that she is infected with this contagious disease. The animal may be an in-calf heifer, or an older cow which has never aborted, and, to all appearances, quite normal in either case. Even after being taken into the new herd the infected animal may escape suspicion, for she may carry her calf to the full period of gestation. Within a few months, however, other pregnant cows in the herd begin to abort, for the infection has entered.

Thus we are confronted with a disease widespread in distribution, highly prevalent, markedly contagious, insidious in its onset, difficult to diagnose, and involving great financial loss. The problem as stated is a difficult one, the factors many and complex. It will be interesting to discover how far veterinary research of recent years has elucidated the problem, and what still remains to be done.

Even after culture through many generations on artificial media, the organism can be used to infect other animals Although the disease naturally attacks only the cow, yet the females of most of the domesticated animals can be infected and abortion induced in them. Of the small experimental animals the guinea pig is readily infected, and inoculation of this animal provides a very useful method of obtaining a pure culture from contaminated or sparsely infected material. If such material be injected into the peritoneal cavity of the guinea pig the animal usually suffers no apparent inconvenience, but if killed in four or five weeks' time will be found to have a slightly enlarged spleen, from which pure cultures of the abortion bacillus can be obtained.

But this line of proof is strongly supported by certain biological tests, which can be applied to a cow suspected of being infected with the disease. It is common knowledge that for the diagnosis of typhoid fever in man a small sample of blood is taken from the patient for testing. The test depends on the fact that when a man or an animal is attacked by the micro-organisms of a disease, the blood of the man or animal proceeds to manufacture munitions of defence, which accumulate in the blood, and can be detected there. Among many others, some substances called "agglutinins" are commonly formed, and these have the peculiar property of crowding together, or clumping, or agglutinating, the specific bacteria responsible for the particular disease when such organisms are suspended in a fluid. Thus a liquid culture or other uniform suspension of the typhoid bacillus, if examined in a hanging drop under the microscope, is seen to be crowded with freely movable organisms, hurrying and scurrying in all directions. If to such a preparation a minute quantity of blood from a person affected or recently recovered from typhoid fever is added, and the result observed under the microscope, it will be noticed in the course of a few minutes that there is a tendency for the bacilli to congregate into small groups and at the end of an hour the field shows a number of such clumps with clear spaces between them, and no freely moving bacilli. With a similar quantity of the blood of a normal person no agglutination or clumping would take place, and so the test is of diagnostic value.

A similar test can be applied in many other diseases, and McFadyean and Stockman in London showed its value in relation to contagious abortion of cattle. In this case, however, the test is performed in a somewhat different manner. Into each of a number of small test tubes is put an equal quantity of a faintly hazy suspension of the abortion bacillus. Amounts of blood serum of a suspected cow are now added, commencing with, say, 1-10th c.c. in the first tube, then 1-20th, 1-50th, 1-100th cc., down to 1-1000th c.c., or less in succeeding tubes. The mixture in each tube is shaken, set aside in the incubator for 24 hours, and then the tubes are examined. If the cow is infected with contagious abortion there will be agglutination of the bacilli in the suspension. As a result the larger masses will usually sink, and leave the supernatant liquid quite clear, the masses forming a matted sediment. Sometimes the clearing is incomplete, though clumping is evident.

There is sometimes some clumping with the blood serum of a normal healthy cow when a relatively large amount of serum, say ½ or ⅕ c.c. has been used. What is diagnostic of the disease, however, is the occurrence of agglutination when only 1-100th or 1-1000th c.c. of serum is used in a tube. The experiment is controlled by the fact that tubes containing a similar suspension of the bacilli without the addition of any cow's serum, remain hazy and unsedimented. Further, the addition of similar minute quantities of serum from known unaffected

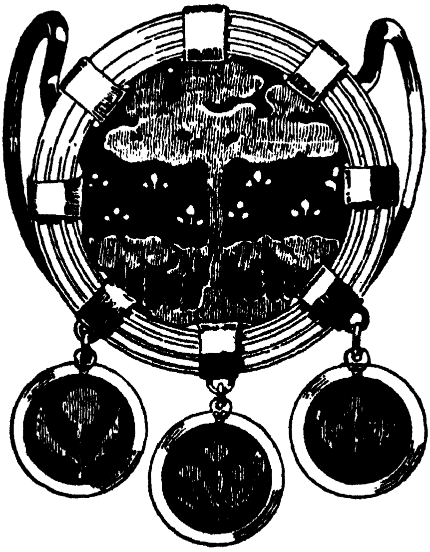
bovines causes no agglutination, whilst the serum from a cow known to have aborted, and to have had the abortion bacillus present in the membranes or discharge, produces complete agglutination when added in very minute quantity. This test has been very widely applied in practice in England, and its usefulness and reliability have been confirmed by numerous workers in other countries, notably the United States. Working in the Veterinary School of Melbourne University, Seddon* has proved the general applicability of the test under local conditions, and has suggested a standardized method of carrying it out which allows of comparison of results in different countries.

Further he has shown that the milk of suspected cows can be used instead of blood serum, so that by means of a sample of milk sent to the laboratory the owner of a cow can be informed whether that animal is infected with this disease. Since milk diluted with water remains hazy, and since this partial opacity makes the observation of agglutination difficult, Seddon has advised the use of lactic acid to precipitate the casein and removal of the curd by filtering. The clear whey is then used in the test in exactly the same manner as blood serum.

When first the agglutination test was used, doubt was cast upon the results obtained because only a few of the animals which gave positive results in the test ever aborted. Thus either the test was unreliable, giving far too many positive reactions, or the symptom which had been looked upon as the almost invariable concomitant of infection, namely, the act of abortion, was, in fact, shown by only a minority of the animals infected.

*The Agglutination Test in the Diagnosis of Contagious Abortion. Proc. Royal Society, Victoria, Vol. XXVII. (new series), Pt. II.

(To be concluded.)



New Research Committees.

FOREST PRODUCTS COMMITTEE.

Professor Watt (Chairman), Sydney University.
R. Dalrymple Hay, Chief Forestry Commissioner.
H. W. Jolly, Forestry Commissioner.
Norman Fraser (Messrs. Bell & Fraser), Rozelle.

Head-Quarters: Sydney.

W. A. TICK-PEST COMMITTEE.

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Mr. M. P. Durack, M.L.A., Parliament House.
Mr. A. Male, St. George's House, St. George's-terrace.
Mr. Percy Hutton, Keane-street, Cottesloe.
Mr. A. Watson, c/o Messrs. Forest Emanuel.
Mr. R. E. Weir, Chief Inspector of Stock, representing the State Government.
Mr. C. S. Nathan (Chairman), representing the Institute of Science and Industry.

Head-Quarters: Perth, W.A.

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Mr. E. C. Lycett (Messrs. Lycett Pty. Ltd.), Montague, Melbourne (Corresponding Member).
Mr. D. Jones, Department of Agriculture and Stock, Brisbane.
Mr. A. H. E. McDonald, Chief Inspector of Agriculture, New South Wales (Corresponding Member).
Mr. C. Napier, Cockatoo, Victoria.
Mr. W. J. Spafford, Department of Agriculture, Adelaide (Corresponding Member).

Head-Quarters: Melbourne.

WHITE ANT COMMITTEE.

Mr. A. A. Ramsay, Agricultural Chemists' Department, Sydney.
Dr. G. P. Darnell-Smith, Department of Agriculture, Sydney.

(Other members not yet appointed.)

Head-Quarters: Sydney.

CATTLE DIP COMMITTEE.

Professor J. Douglas Stewart, University, Sydney.
Professor Fawsitt, University, Sydney.
Mr. F. B. Guthrie, Agricultural Chemist, Sydney.
Mr. S. T. D. Symons, Chief Inspector of Stock, Sydney.

Head-Quarters: Sydney.

WHITE EARTHENWARE COMMITTEE.

Mr. M. Copland, Director, Ballarat School of Mines.
Mr. V. G. Anderson (Messrs. Avery and Anderson), Melbourne.
Mr. W. Baragwanath, Geological Survey Office, Mines Department, Ballarat.
Mr. W. Miller, Eureka Terra Cotta Co. of Australia, Ballarat.

Head-Quarters: Ballarat.

Chemists and Industry: Some Points for Consideration.

By A. C. D. RIVETT, M.A., D.Sc.

At the end of the crowded four years that have made unexampled wreck of wealth and even more striking wreck of ideas and points of view, it is essential that time and thought be given to the re-adjustment that will be necessary in the attitude of many professions to the national life. The medical profession, for instance, has certainly much adjustment to make before its relation to the community resumes a placidity equal to that of former years; and it is not alone in this. There is, among students and exponents of science and scientific methods, still greater necessity for a new outlook, and a reconsideration of the old relationships to the community at large. Much thought is being given to this in the leading countries of the world, and in particular is attention being devoted to the position of scientists relatively to directly industrial life. It is not, however, proposed to discuss here so large and general a matter as the work and aims of scientists in general in their bearing on industry, but merely to raise some few points concerning one special section—the chemists.

During the war, chemists have occupied a unique position. Since the first rather chaotic months, it has been the policy of most countries to retain their chemists, so far as possible, for purely professional work, exempting them from the obligation to undertake war service in directly combative branches. It is true that during the time when the practice prevailed of discharging poison gas in clouds chemists were required to carry out the work in circumstances of the utmost danger. But that period was limited, and for the most part chemists' work has been behind the front lines and in the munitions factories, where danger, though not inconsiderable, has been of a different order from that risked by the men immediately confronting the enemy.

Perhaps on this account more may be expected of chemists in the sequel to the war. Certainly their duties in national service remain very definite. The end of the fighting has left the chemist in a different position from that of the soldier. The immediate activities of each have ceased, but the need for the exercise of the chemist's powers in other (and not so very dissimilar) directions without delay is imperative. Every belligerent country, Australia included, is burdened with a colossal debt, a huge decrease in its wealth. Its pressing problem is to free itself from this burden by production as vast as its expenditure has been prodigal. Australia, admittedly, must look first to her primary industries, in which the chemist's part, though far from insignificant, is not all-important. But also, and to an extent not very inferior, she must look to numerous secondary industries which require for their full development, in greater or less measure, investigation and control by the chemist. In these it is true that his opportunities may be limitless; yet it is also a fact that such scope as is frequently enough offered at present may not be very attractive to him. Not seldom the career of the technical chemist is one of heavy routine and frequent disappointment, and by no means a succession of fascinating problems and triumphant discoveries.

But the point to be emphasized is that in these days, as never in the days before August, 1914, national duty rather than personal preference must enter largely into a man's consideration of his course of action. Granted that production must be largely increased in Australia to pay the cost of the war, and granted that chemists properly trained and properly applying their training may contribute greatly towards this end (and no man of knowledge or judgment

will deny either premiss) it follows that there is an obligation laid upon every chemist to consider sincerely his attitude towards the country's claim upon his service in the technical development of its industries. Such a view, at any rate, is commended to those in training for some sort of a chemical career, and those who may be considering the matter of choosing one.

It is not in place here to expound the necessity of applying science to industry. To those with a clear view of what "science" means it is unnecessary; to the many without it the exposition has been made sufficiently often in recent years. Australia is certainly recognising this need, though in a measure by no means so definite and hearty as many other countries. In reading the discussion which took place last year in the Senate upon the Ministry's proposal to create an Institute of Science and Industry, one was not a little surprised to find how far the opinions of certain senators were lagging behind those now accepted by their legislative confrères in America, Great Britain, the sister Dominions and Japan. If such opinions prevail, Australia falls out of a world-wide movement. Already she lags behind.

But it is the aim here rather to ask whether, given the opportunity by Parliament, Australian chemists are prepared to attack the problems that already exist and those that must be raised; not so much whether their spirit be willing as, firstly, whether the weapons at their command are sufficient and the best, and, secondly, whether they are determined to obtain for themselves those conditions under which their weapons may most effectively be used.

In discussing the first matter, one addresses oneself chiefly to chemists. Few will disagree with the statement that the young graduate of technical school or university is very indifferently equipped for the part of technical adviser in any industrial process. Least of all will the young graduate himself disagree. His subject has become too great for more than a limited general acquaintance to be made with it in three years or so. Nor is it wisdom to attempt to cram into these years more chemistry; indeed, there is much reason to suppose that a wiser course would be rather a diminution of chemistry and an increase in acquaintance with neighbouring sciences, and even (if one may risk the suggestion) with logic, philosophy and literature. The dogma that is an age of specialization is nearly dead, after a life of great harmfulness. The university's part is to cultivate a point of view, a capacity to see and to follow a track without losing sight of its relation to other tracks; not to teach the minutiæ of a single isolated path.

And if this be accepted, the graduate of the future will be still less ready straightway "to apply science to industry," or to do it even after he has mastered the whole existing plant details of his particular chosen industry. The holder of a technical school diploma or a university degree is at the beginning, not the end, of his preparation for original industrial work, and nothing is more unfortunate than the way in which the habit of hard study is dropped by students almost as soon as it has been properly acquired, and just when its exercise becomes capable of great things. Post-graduate study is not merely desirable, it is essential. The graduate who fails to recognise this is dropping out of the running. He is doing worse; he is assisting, by bringing himself to a standstill, to discredit his science and those who, by their strong faith in it, are striving to induce the industrialists to give the scientist a chance. We have never quite realized in British countries how long it takes to make a sound technical chemist capable of original work, and how foolish it is to make a man work hard for three years in order to acquire a more or less general education and to pass examinations, and then take no further thought regarding the later years in which his powers should be concentrated upon the specific branches in which he might become a creator of knowledge.

To speak thus in general terms is somewhat idle unless specific suggestions follow. Having in mind the quite unprecedented development of chemical processes in England and elsewhere in recent years, it would appear that the chief advances have been made by men who, while well trained along the more usual lines, have been especially capable of applying the results of two particular studies. The two are ultimately connected, and are the study of thermodynamics on the one hand, and on the other the study of heterogeneous equilibria from the stand-point of the so-called phase rule. The number of men capable of applying the former will always be limited, but it may be doubted whether there is any chemical manufacture in which advance may not be effected by a chemist thoroughly familiar with the weapon of the phase rule. This is not the place to show by examples what has been done in England to justify this statement; nor even to name the investigators whose brilliant work has made possible those achievements in munitions chemistry which have meant to the Allies far more than most people will ever realize. Systematic researches on the lines mentioned have proved, in the chemist's hands, to be weapons as powerful as any he has ever possessed for dealing with manufacturing problems. But what is especially to the point here is that all this has shown that the training required by the expert technical chemist has become broader and deeper than ever before. No technical school or university can include in its general course a sufficiently detailed study of all the sections of chemistry now required; there is too much else to be included. More must, therefore, inevitably be thrown upon the student after graduation. Yet to leave these difficult studies entirely to his own initiative is not only unjust, but it is to some extent wasting time. Post-graduate instruction of a special kind must be provided for the first one or two years after the chemist has entered a works, and while he is making his first practical acquaintance with works methods and works machinery. If it be not provided, there will be few who will succeed in reaching anything more than the position (and value) of a works analyst.

That brings one to the second matter under discussion—the position of the chemist in the works. There is nothing to be gained by blinking the fact that to many manufacturers the job of the chemist is to conduct the routine analyses of gases, liquids or solids at "test" points of the process. Nor is it any use blinking the fact that so long as the manufacturer persists in that view, he is doing little more to apply science to his industry than does the maker of engines to devise new and better machines when he merely employs a gang of greasers. It has to be recognised that there are grades of chemists; there are, one may say, the non-commissioned as well as the commissioned ranks. It is the duty of the former to carry on; so long as the latter are compelled to spend their hours similarly, it is clear that all expectation of improved strategy and tactics must go.

The chemist who will devise and improve processes is the one who supervises and criticises the analytical detail, but does not himself carry it out when it has become a routine; who is free to spend hours on the plant examining the working of this, that, and the other detail; who is free to devote himself (in working hours) to reading everything with a bearing on his subject; who is given definitely to understand that his time is to be filled not merely with "process managing," but with process devising and process improving. It is in this sense that one speaks of the chemist in the works who will "apply science," and it is only the chemist who demands and obtains these opportunities who will be assured of success.

It is perhaps not irrelevant to remark upon an expectation amongst some factory-owners that their problems may be solved by sending them to an outside

expert, or even to an inside investigator, installed in a laboratory, not familiar with the technical details of the plant. No doubt some help may be gained in this way; no doubt a measure of safety regarding plant secrets is also gained. But there is a fundamental error in the method, namely, the assumption that a problem can be recognised and properly and completely stated by any one but the man capable of solving it. The chemist must demand to know all that is already known, otherwise he starts handicapped. Put quite bluntly, the manufacturer must show his hand completely to the chemist from whom he hopes for assistance; and this involves a relationship of a very confidential nature.

This particular point cannot now be more fully dealt with: but in connexion with the Institute of Science and Industry it is of fundamental importance so far as the chemical side is concerned, and it must be given full and final consideration as soon as possible. It is presumably the Government's intention that, in the matter of chemistry, this Institute shall be of use to various private industries, either in being or about to be initiated, in the prosperity of which the country is deeply concerned. For the officers of the Institute to be of service to manufacturers, it is necessary that some of them be entirely in the confidence of the manufacturer. On the other hand, no manufacturer wishes to give an outsider the confidential technical details upon which his process is based; and his diffidence will be all the greater when the outsider is one who may have equally confidential relations with other manufacturers. This is a problem that has to be faced if disappointment is to be avoided, and the first essential is to state it in all its difficulty. There is reason to believe that it is not beyond solution. It has not proved to be insoluble in America. But if it does prove beyond solution here, it will be necessary to recognise quite candidly that one side of the Institute's activities upon which the Government counts is closed.

Assuming, however, a solution for this primary difficulty, there remains before the Institute the big question of finding suitable men for the work which it will undertake. That chemical industries must and will flourish in Australia is as certain as that they are going to flourish to an extent hitherto undreamt of in America and Great Britain, on the Continent, in Japan, and in the other Dominions. These countries will produce their own chemists. No doubt they will also be able to produce those that Australia requires; but it will be a most unfortunate confession of failure if we cannot fill our own technical posts with our own men. Therefore, the matters of their training and their professional status cannot too soon be settled, and the proposed Institute is most intimately concerned with them. All the organization that is possible will be ineffective unless the necessary men and women with adequate training are available to study the problems that will arise. It will naturally be one of the Institute's continuous aims to secure the best possible skill for its investigations, and it must look, not merely to the educational institutions of the country, but to the initiative and enterprise of the young graduate in science for the heavy preparation that will be necessary before success in original inquiry is assured.

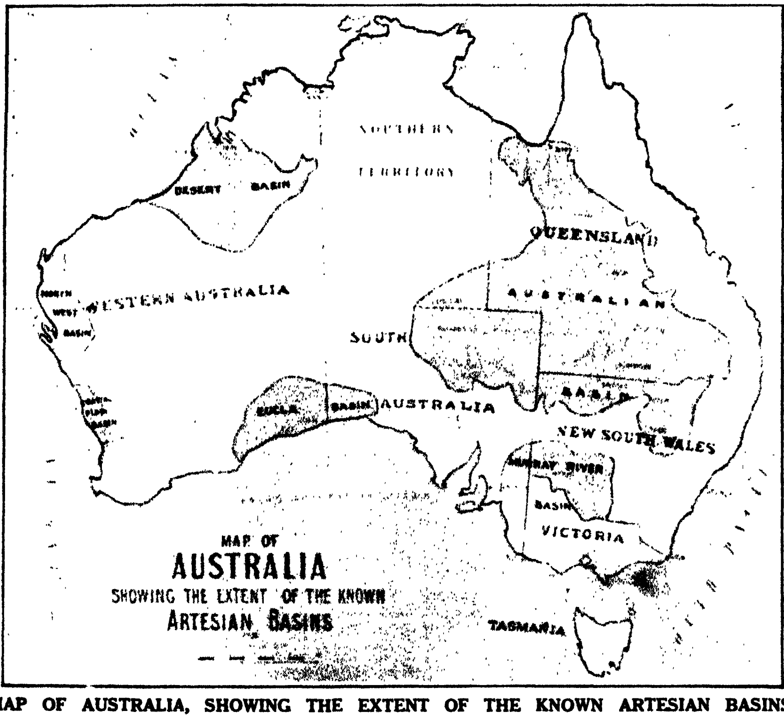
Much has been promised on behalf of chemical science; when the opportunity comes it will take all the energy and enthusiasm of our chemists to redeem the promises and to make for themselves in the national life a place worthy of their science.

Artesian Water Problem.

By Prof. H. C. RICHARDS, D.Sc.

The possession by Australia of immense supplies of subterranean water, which is readily made available at the surface, may be regarded as a very distinct set off against the drought-stricken condition to which most of the overlying area is periodically subjected. Australia really possesses several artesian water-basins or areas which may be supplied with underground water by means of bores, and up which the water is forced above the surface of the ground by natural pressure.

The most important of these basins is the largest of its kind that is known, and it embraces approximately half of Queensland, very considerable areas in New South Wales and South Australia, and a small portion of the Northern Territory. This basin, which has an area of the order of 600,000 square miles,

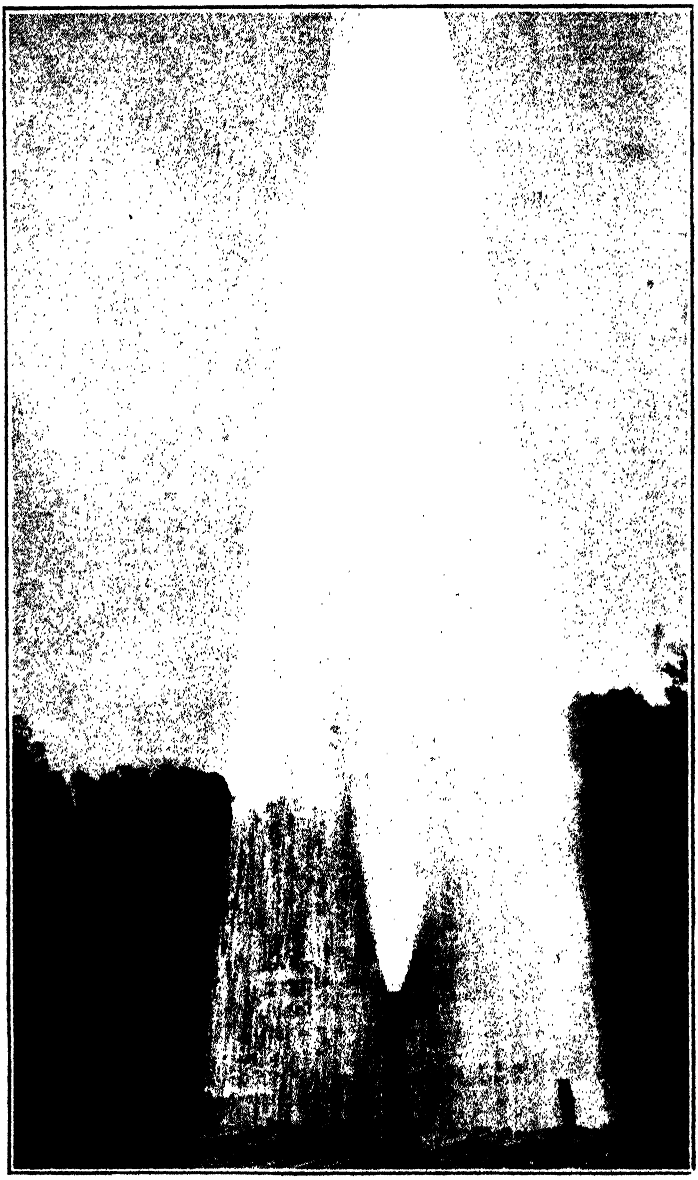


MAP OF AUSTRALIA, SHOWING THE EXTENT OF THE KNOWN ARTESIAN BASINS.

is known as the Great Australian Artesian Basin. In this basin there are some 3,500 bores, yielding a daily flow of between 600 and 700 million gallons of water. This water, which has been drawn upon since 1880, has been of very great benefit in watering large areas of country used for pastoral purposes and for providing water along the great overland stock routes, and our knowledge as to the source and supply is not commensurate with the great part it has played, and will continue to play, in the development of our country. To the late H. C. Russell, Dr. R. L. Jack, Professor T. W. E. David, and Mr. E. F. Pittman we owe much for the information we have about the general structure of this basin, and the source of the water, and in particular to the writings of the latter, to whose recent work* reference may be made for the bibliography of the matter.

*E. F. Pittman, "The Great Australian Artesian Basin," Department of Mines, New South Wales, 1914.

Until about 1906 it was generally accepted that the water furnished by the bores was really impounded rain-water, which had soaked into the porous upturned edges of the basin along its eastern and south-eastern margins; that these porous intake beds were bedded beneath layers impervious to water, and, in their turn, rested upon impervious material, and that as the intake beds out-



CLAVERTON DOWNS BORE No. 2, QUEENSLAND.
In 1897 the daily flow was 1,330,000 gallons, while in December, 1910, it had decreased to 737,400 gallons.

cropped at a height well above those places where the water was forced above the surface through the bores, the pressure causing this uprush was due to the hydraulic pressure of the impounded water.

The above is a very general outline of what is known as the "Meteoric Hypothesis" as to the origin of the water, and in terms of it many correct predictions as to depths to be bored and flows to be gained were made. The question as to whether the water found natural subterranean outlets to the Gulf of Carpentaria came in also: but the essential idea was that the water was rain-water which has percolated into the porous upturned edges of the basin where rainfall and flowing rivers were abundant.

In 1906 "The Dead Heart of Australia," by Professor J. W. Gregory, was published, and was the result of a visit to Central Australia by that author together with several of his students. In this publication and subsequent ones by the same author, the "Meteoric Hypothesis" was criticised and regarded as being untenable, while great prominence was given to a plutonic source of the water. Plutonic water is regarded as rising from the interior of the earth, having been given off by cooling intrusions of igneous plutonic rock. Certain physical and chemical information was put forward by Professor Gregory in support of his views. This has formed the basis of the so-called "Plutonic Hypothesis." From 1906 until 1914 a rather bitter controversy raged between the chief advocates of the two main hypotheses as to the origin of the water and other matters. While one deplores the warmth with which the controversy has been waged, the result has been that a great deal of interest in the matter has been taken by scientific investigators and others, and it has been shown quite clearly that many factors in connexion with this great and beneficent supply are not understood, and that it is a matter of concern to several States that the several problems associated with the matter should be investigated.

The problems requiring investigation are geological, chemical, and physical, and a better understanding of several matters might well result in considerable advantage to future generations in Australia. Quite apart from all other matters, it is clear that there is a very serious diminution* in the total outpouring of the artesian bores, and estimates of an annual decrease up to 8 per cent. in amount for some bores in certain areas which have been remeasured are based on thoroughly sound observations. In some cases local causes, such as blocking of casing, corrosion of casing, &c., may be put forward to explain the decrease in flow, but in the opinion of those best competent to form an opinion, both in virtue of experience and training, the observed reduction of flow from individual bores is thought to be due to a general falling off in the supply of the basin rather than to local causes.

The fact that some bores have ceased flowing, and that the official records show a steady annual decrease in outpouring for practically all bores that have been examined must be faced. Any means that can be adopted to control the artesian supply, to utilize it so that no waste takes place and to preserve it should be taken. Legislation has been introduced in the various States, but it has not been submitted to with good grace by many, as they feel it is based on an incorrect hypothesis—the meteoric hypothesis—as to the origin of the water. Even if one conceded that the meteoric hypothesis is incorrect in basis, the adoption of the rival idea should necessitate a more stringent regulation. The meteoric hypothesis, which was accepted in a general way for many years, has, during the last decade, had many attacks on it, and while it explains most of the facts we know about the basin, there are certain matters, such as temperature, pressure, and the composition of the waters, which it is difficult to explain in terms of it. Some years ago the great importance of ascertaining all possible information about this national asset, in order to legislate for efficient control, regulation, and preservation was placed before the several State Governments, and in 1912 the first Inter-State Conference on Artesian Water was held in Sydney. Representatives of the five States concerned with artesian water met, and resolutions were passed in regard to the advisability of simultaneous action by the different States to provide for—

1. The delimitation of the artesian areas.
2. The carrying out of a hydrographical survey, including—
   (*a*) The gauging of the flow of streams within the artesian areas;
   (*b*) the measurement and recording of the flows of all bores.

*Report, Second Inter-State Conference on Artesian Water, Brisbane, 1914, pp. xiii-xv.

3. The adoption of a uniform system of collecting and designating rocks obtained in boring.

4. The passing of legislation to prevent persons from boring for artesian waters without first obtaining a licence, and for the general control by the State of all artesian bores in the public interests.

5. The adoption, for facilitating comparison, of a common system of recording bore water analyses.

6. The appointment, for the purpose of preventing the unnecessary multiplication of bores, of a permanent Board of competent officials in each State, without whose recommendation no new bores should be constructed.

7. The adoption of a system of bedding the casing upon an impervious stratum, and sealing it with cement, where possible, with a view of preventing leakage, and thus minimizing the decrease of flow from artesian bores.

Most of the work referred to in these recommendations has been started in the States of New South Wales and Queensland.

In 1914 the second Inter-State Conference was held in Brisbane, and was composed of the Government Geologists and Hydraulic Engineers from the several States. The following investigations were recommended:—

1. Influence of thickness of water-bearing beds upon pressure and flow.
2. Comparison of pressures and flows in bores where the potentials are apparently the same.
3. Correlation of temperatures, pressures, and flows.
4. Range of increase in pressure when bores are closed, and the time required to attain maximum pressure.
5. Rate of diminution of flows, with details of any special interest.
6. Variation in water level in non-flowing bores.
7. Correlation of depths and temperatures.
8. Expansion of water column with varying temperatures.
9. Comparison of analyses, where practicable, from each flow in the same bore.
10. Comparison of original with later analyses.
11. Comparison of temperature and saline constituents.
12. Qualitative and quantitative examination of gases evolved from bore waters.
13. Volume of gas per unit of flow and its relation to discharge.
14. Influence of gas on pressure.
15. Influence of gases on corrosion of casing.
16. Porosity and texture of water-bearing rocks.
17. The source of the saline constituents of the water.
18. Locating mud springs and gauging their flows.
19. Results obtained from bores cleaned out but not deepened.
20. Detailed investigation of all phenomena in bores in which corrosion of casing has been detected.
21. Mutual interference of bores.
22. Results obtained by the use of air lifts for increasing discharge of bores.
23. Distribution losses in bore drains.

The proposed third conference in Adelaide in 1916 did not eventuate owing to war conditions, and there has been no further meeting of the officials concerned since 1914. The question is of great urgency, and should be taken up again at the earliest moment, and any obstacles in the way of carrying out the investigations on the problem should be overcome, if at all possible, in order to conserve the water.

The most authoritative body which has yet dealt with the question is the abovementioned body, and at the first conference it expressed itself as follows:—"As there has been a considerable amount of controversy in regard to the origin of artesian water and the cause of its flow, we have given special consideration to the question, and have no hesitation in stating that, in our opinion, the ascertained facts indicate that the water is almost wholly, if not entirely, derived from rainfall; and that it percolates the porous beds under the influence of hydraulic conditions."

Since that time Professor Gregory has published a paper in the Queensland *Geographical Journal*, 1914, ascribing the water to four different sources—

1. Rain-water, which percolates underground along the exposed edge of the basin.
2. Water which was included in the beds during their formation, and has been stored up in them—water of cisternage.

3. Fossil water probably soaked into the beds at an earlier geological period.
4. Plutonic water, which rises from the interior of the earth.

That author says he cannot satisfactorily determine the percentage of plutonic water, but thinks that Mr. Symmonds' percentage* of 80 is too high. He thinks the bulk of the water is water of cisternage, but that the energy of the plutonic water is probably more important than its quantity.

It is thus seen that the chief advocate of the plutonic hypothesis still considers that he retains his ground, and there are in Australia several adherents.

The real point to be ascertained is how long will the water last? To answer that a great deal of work is necessary in thoroughly geologically surveying the intake beds, in gauging the rivers flowing over these beds, and in various physical and chemical investigations.

The proper compensation to be paid for bores on areas resumed by the Crown is a matter that rests on the solution of this water problem, and may be cited as a matter which frequently arises, and at present cannot be properly settled.

EULOLO BORE, No. 2, QUEENSLAND, BEING MEASURED FOR FLOW.
In December, 1914, this bore had a daily flow of 407,000 gallons.

The failure of a bore to flow naturally after a number of flowing years does not mean that the bore has lost all its value, as large quantities of water may still be obtained by means of pumping or by an air-lift.

It is improbable that artesian water will ever be used to any appreciable extent for irrigation, and its great value is for pastoral purposes.

As the records† show that the aggregate flow is diminishing at a rather alarming rate, the effect on pastoral industry in the future is easily imagined.

The cause of the diminution must be clearly ascertained, and any possible remedy that is of value should be adopted. The permanent Board appointed as a result of the first Inter-State Conference has not met since 1914, and meanwhile the decrease of flow goes on. The urgency of the matter must be appreciated, and all possible steps taken to deal with the problem.

*"Our Artesian Waters," Government Printer, Sydney, 1912.

†Report, Second Inter-State Conference on Artesian Water, Brisbane, 1914, pp. xiii-xv.

The illustrations accompanying this article were prepared from a map and photographs very kindly supplied by Mr. John Hargreaves, the Hydraulic Engineer for Queensland.

Engineering Standardization: United Action.

In 1918 attention was given by the Executive Committee of the Advisory Council of Science and Industry to the question of establishing in Australia an Engineering Standardization Committee to be in direct communication with the British Committee in London, and to act in an advisory capacity to that Committee, and to draw up standard engineering specifications for the Commonwealth. After considering the matter, the Executive Committee, with a view to focussing attention on the matter and eliciting the support of persons interested throughout the Commonwealth, in November, 1918, requested each State Committee to invite representative persons in the respective States to hold a meeting to discuss the following points:—

(a) In view of the importance of standardization of engineering materials and methods, the desirability that such standardization should be considered for Australia as a whole.

(b) In view of the fact that great progress has been made in Great Britain and the United States of America in such work of standardization, the desirability of accepting such standards as have already been arrived at, provided they are satisfactory to Australian conditions.

(c) In cases when British and American standards are equally applicable to Australia, the desirability of selecting the British standards.

(d) The desirability of establishing in Australia a representative authoritative body to take the matter in hand.

Meetings in each State have been held, and copies of the report of the proceedings have been forwarded to the Executive Committee.

In New South Wales, three members of the Advisory Council and 31 engineers, representing various engineering organizations and Government Departments, were present. Five resolutions were unanimously passed—the first four being in the terms of the points referred for discussion, as specified in paragraphs (*a*) to (*d*) above. The fifth resolution was as follows:—

(e) That, in view of the action in Great Britain, where the British Engineering Standards Committee was formed in 1901 by representatives from the Institute of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers; and, in view of the action of the United States of America and other foreign countries, where Standardization Committees have been appointed by the various engineering institutions in those countries, it is recommended that the Engineering Standards Committee of Australa be appointed by the various engineering associations or societies at present existing in Australia, and shall include engineers appointed by the Government Departments and Public Utilities.

This last resolution had been unanimously adopted at a preliminary meeting of representatives of the New South Wales section of the Electrical Association of Australia, the University Engineering Society, and the Engineering Association of New South Wales. It was pointed out during the discussion that the proper body to take the matter in hand is now in process of formation, and will be in existence in about six months' time—the Institution of Australian Engineers.

In Victoria, four members of the Advisory Council and nineteen representatives of engineering organizations, Government Departments,

&c., were present at the meeting. Resolutions were passed affirming points (*a*) to (*d*) above, and, in addition, the following was passed unanimously:—

(e) It is desirable that such a movement be linked up as a branch of the British Engineering Standards Association.

In Queensland, three members of the Advisory Council and nine other representatives were present at the meeting. The points referred to in paragraphs (*a*) to (*d*) were unanimously affirmed. In addition, the following resolutions were unanimously passed:—

(e) That it is the opinion of this meeting that Queensland should be represented on the local Committee in Australia, which will be in direct communication with the British Engineering Committee in London.

(f) That this meeting considers that each State should be separately represented on such sectional Sub-committees as may be formed.

At the South Australian Conference, in addition to Professor Rennie, who was in the chair, eight representatives of engineering organizations, &c., were present. Resolutions affirming points (*a*) to (*d*) were passed unanimously. In addition, the following resolution was passed with one dissentient:—

(e) It is desirable that such a movement be affiliated with the British Engineering Standards Association.

In Western Australia, in addition to members of the Advisory Council, thirteen engineering and technical organizations and departments were represented. The following resolutions were passed:—

(a) That this meeting cordially supports the principle of standardization, and the Commonwealth, being part of the British Empire, the meeting is of the opinion that the British standards should be, as far as possible, adopted in Australia, in preference to setting up separate standards.

(b) That the President and Council of the Western Australian Institute of Engineers, together with Professor Ross, of the University of Western Australia, and Mr. Montgomery, of the Western Australian Committee of the Council of Science and Industry, be appointed a Committee to keep in touch with the Advisory Council in Melbourne in matters affecting standardization in Australia.

The opinion was also expressed and agreed to by those present that a well-equipped branch of the Physical Testing Laboratory should be established in Perth, possibly in conjunction with the Forest Products Laboratory, as, owing to the distance of Western Australia from Melbourne, it is desirable that it should be possible to check instruments and standards in Perth.

At the Tasmanian Conference, three members of the Advisory Council and five representatives of engineering organizations, &c., were present. The three following resolutions were passed unanimously:—

(a) That the meeting heartily indorses the suggestion for the establishment of an Engineering Standardization Committee of Australia, and urges prompt action in connexion therewith. It further recommends that the Committee should be, in the first instance, formed by appointments on the recommendation of the engineering societies of Australia, such appointments to include manufacturers' representatives, and also by appointments representing Government Departments and Public Utilities.

(b) That the meeting affirms the principle that British standards should be adopted as far as possible.

(c) That the representatives present at this meeting undertake to urge upon the bodies they represent to support the principle of standardization, and to prepare the ground for the Australian Engineering Committee, by adopting British standards forthwith wherever possible.

Leaks in Fruit Containers.

R. GREIG-SMITH, D.Sc.

"The Tin Factory, in what might be termed its trial run, was an expensive experiment. In a total of 107,191 2½-lb. cans made by this Factory, and used in canning, 15,408 were found during processing to be leaky, and of those manufactured and purchased 5,013 developed leaks in the warehouse. Besides these, 6,959 were spoiled in manufacture, and 4,773 faulty cans were found amongst those purchased. These make a total loss of 14.7 per cent. of the 2½-lb. cans used. Further, of 3,140 No. 10 cans purchased, there was a loss of 23 per cent. through leaks. It is still a controversial point as to where the fault lies, but in the light of cold fact, wherever the fault, considerable monetary loss has been the result."

—State Industrial Undertakings (New South Wales) Report of the Auditor-General, 1918, p. 77.

The quotation is interesting in showing the heavy loss that may occur in a cannery, even with the most improved plant, for that at Leeton, on the Murrumbidgee Irrigation Area, is of the most modern type. It may be that much of the loss was caused by the faulty closing of the containers, for that is the weak point about the preservation of fruit and vegetables. Unless solder is used, no machine can fit on a lid and make the container absolutely air and water tight, that is, make it equivalent to a hermetically-sealed vessel. There is always a weakness where metal joins metal with a non-metallic luting material at the points of contact. The internal pressure developed during the processing finds out the weak places, and there is leakage, with its attendant troubles.

My attention was called to the irregularities in the canning process by one of our leading fruit-canners, who desired to know the reason for the "springing" of his tins of preserved fruit. Some time after processing, the tins, which normally should have concave ends, indicating a partial vacuum within, become bulged at one or both ends, clearly showing that internal fermentation has occurred. Such containers are condemned as containing food unfit for human consumption, as doubtless they do. Putting them through the boiler again, that is "reprocessing" them, does not do much good, as they may become worse, and the reason for this becomes evident when the cause of the "springing" is understood.

In processing pears, for example, the fruit is pared, halved, cored, washed, and filled into the empty containers, which are placed upon a travelling belt. A girl fills them with boiling syrup up to anything from half to a quarter of an inch from the top. Then they pass to the closing machine, which turns the lid on the cylindrical wall of the container by forming a double interlocking hook. The tin goes to the boiler, where it is cooked. On emergence from the boiler, the tins are stacked on the floor of the cannery until they are sufficiently cold to enable them to be taken to the storage room, where they are arranged in tiers. After a time many of them begin to ooze syrup from the junction around the top or bottom, and the leakage may continue, or it may stop, and the syrup hardens, forming a lute of dried syrup. It is among these that the springers are afterwards found.

The "springing" results from the production of gas inside the tin, and, as this is unable to escape, the top is forced outwards, and the pressure may be so great as to cause the syrup to be forced out through the junction of the lid with the side of the tin. The gas must be produced by the action of micro-organisms, unless it be by the activity of fruit enzymes. The latter is unlikely, partly because of the heat to which the contents have been subjected during the cooking process, and partly because, if they were the agents, every tin would be a springer. The closed tins are put through a boiler, and are in the boiling water for sixteen minutes, which, according to laboratory experiments,* is quite enough to thoroughly pasteurize the contents. One should, therefore, look to the subsequent treatment for the cause of the trouble. We found that the active organisms were yeasts, and as these could not have persisted through the cooking process, it follows that they must have gained entry afterwards. The most plausible suggestion is that the lids are not absolutely

* "The 'Springing' of Tins of Preserved Fruit." By W. W. L'Estrange and R. Greig-Smith, Proc. Linn. Soc., New South Wales. 1918, p. 409.

sealed. Previous to fixing on, the margins of the lids are painted or dusted with a composition, which packs the space between the flanges when the lid is turned over the container side. The composition seems to vary. It consists sometimes of flour, dextrin, and finely powdered cork, at others of flour, dextrin, and rice starch. It does not form an impervious lute, possibly because the starch and flour are jellified by the hot water, and blown out by the internal pressure, so that the cork alone remains. As nearly every second tin of pears shows signs of leakage in the storage room, it is evident that the closure of the tins is by no means perfect. A rubber composition is used by some canners, and this should make a more efficient lute.

Since the closing is so imperfect, one is justified in presuming that, as the can cools down and the contained steam becomes condensed, there is an inward pressure or vacuum, and a certain amount of air is drawn inside the tin. This is the root of the trouble. Any living microbe, yeast, or mould which chances to be in the air that is sucked in will destroy the sterility of the contents. If it is a yeast, much will depend upon its power of causing a fermentation of the syrup. Some yeasts produce little gas, others are active fermenters, and will produce "springers." If the organism is an acid-producer, the tin will become a "sour," which may not be of any industrial consequence. The already acid syrup may, with a little more acidification, which is recognisable only by the expert, become so unsuitable to the microbe that it is killed off, and the trouble does not become excessive. It is entirely a matter of chance as to whether any microorganism gets in, or that the organism, getting in, can injure the contents. In a cannery, where so much fruit is being dealt with, one would expect the yeasts that do obtain entry to be fruit yeasts, that is, the kind known as wild yeasts. It was with some surprise, therefore, that we found the yeasts in the majority of the tins to be of the cultivated or brewery type. The anomaly was, however, explained when we learned that next door to this particular cannery there was a factory actively engaged in producing ginger beer. Doubtless they were using the brewery type of yeast, and in sufficient amount to charge the air of the cannery.

While the reason for the springing can be traced to air accompanied by microscopic life being sucked into the tin while cooling, experience tells us that there is something more in it than can be explained by this theory. The "fly in the ointment" is this, that in the storage room about every second tin of pears shows signs of leaking, about every tenth tin of plums, and with peaches, apricots, and other stone fruits, the leaks are few in number. It is possible that the juice of pears has a greater solvent action upon the starch-luting of the container lid than other fruit juices. The subject is of interest, but there can be no doubt about the entry of life into the future springer subsequent to the cooking, and subsequent to the moment when the tins have cooled down to 170° F., or a little lower. The critical time begins when the tins are cold enough for the incoming yeast to be able to exist. Thus there is an appreciable interval between the time that the tins leave the cooker and the entry of potentially active micro-organisms.

The fault is not always with the lid itself. Sometimes the tin plate is spongy, and the syrup oozes through the microscopic holes; at other times the solder cementing the cylindrical wall of the container splits when the metal is turned in the closing machine. Again, there may be a small hole left at the extreme end of the seam, where the metal has been cut to give a single thickness of metal for bending into the hooked joint. The weakness about the process is in the closing of the container.

The remedy is theoretically simple. From the time that the tins are at 170° F. until they are cold enough to work they should be in a sterile atmosphere. Then the edges of the tops and bottoms should be painted with a lacquer to close any microscopic opening. It is not a difficult proposition, and should be easy to accomplish in any cannery.

Personal.

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The Hon. W. Massy Greene is now the Minister in charge of the Institute, in place of Senator Russell, who has gone to the Defence Department.

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Among recent visitors at the head-quarters of the Institute have been:—His Excellency Judge J. H. P. Murray, Lieut.-Governor of Papua; Sir Henry Lefroy, Premier, and Hon. James Gardiner, Treasurer, Western Australia.

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Mr. G. D. Delprat, C.B.E., a member of the Executive Committee, has been granted six months' leave of absence, and has left for a trip to America and Europe.

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Dr. Cameron, Victorian Director of Agriculture; D. H. Avery, M.Sc., of Collins House; H. W. Jepp, Electrolytic Zinc Company, and A. McKinstry, B.A., M.Sc., late Director of Munitions, have been added to the Executive Committee of the Advisory Council.

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Mr. Geo. Valder, Under-Secretary and Director of Agriculture (New South Wales), and Mr. F. W. Reid, Principal of the School of Mines, Adelaide, have also been gazetted members of the Advisory Council.

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Dr. A. C. D. Rivett, of the Melbourne University, and Professor B. D. Steele, of the Brisbane University, are back from munition making. They both resume work at their respective universities.

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Major A. J. Gibson, late manager of the Arsenal, who sat upon the Executive Committee while resident in Melbourne, by reason of his being chairman of the Queensland Committee, has now resigned. He does not leave the Advisory Council, but, being now domiciled in New South Wales, will no longer sit upon the executive. His advice will be much missed.

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Mr. W. B. Alexander, M.A., who for the last two years has acted as science abstractor and editor of publications of the Advisory Council, has returned to his old position as keeper of the Biology Department of the Perth Museum. Before leaving Melbourne Mr. Alexander completed a bulletin on the prickly-pear problem, which will shortly be published. He has been made a member of the Advisory Council.

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Mr. Walter Leitch, C.B.E., late Director of Munitions and Director of the Bureau of Commerce and Industry, has resigned the latter post, and has sailed for Europe. He resumes his position on the directorate of Messrs. Joseph Baker and Sons, and will act as local director for the United States, with head-quarters at Chicago.

PERSONAL.

Mr. Hugh V. McKay, C.B.E., of Sunshine Harvester fame, and a member of the Power Alcohol Committee, is now on his way to the United States on a business trip.

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Mr. C. O. G. Larcombe, B.Sc., Curator of the School of Mines, Kalgoorlie, was amongst those marooned in Melbourne during the influenza scare.

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Mr. Stirling Taylor, General Manager of the Westralian Farmers' Co-operative Society, succeeds Mr. Leitch as Director of the Bureau of Commerce and Industry. The Institute and the Bureau are now more closely associated, as they now occupy the same building.

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Mr. J. B. Henderson, F.I.C., Government Analyst, Brisbane, has been appointed Chairman of the Queensland State Committee of the Advisory Council, in place of Major Alex. J. Gibson, A.M.I.C.E., who has resigned, in order to enable him to take up important duties in connexion with the Broken Hill Proprietary Company's works at Newcastle.

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Mr. I. H. Boas, M.Sc., of the Technical School, Perth, has left for Europe, America, and India, where he will investigate Forest Products Laboratories. His report will form the basis of the Western Australian project.

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Mr. E. N. Robinson has joined the Institute as Assistant Secretary. He has been on the staff of the *Argus*, and was recently loaned to the Defence and Repatriation Departments for special work. He visited Denmark and the United States in 1911, with the view of reporting upon farmers' co-operative schemes, for a syndicate of newspapers.

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Mr. E. R. Pitt, B.A., of the Melbourne Public Library, has become Librarian of the Institute. In 1905 he was intrusted with the compilation of the "Catalogue of Current Periodicals received at the Public Library" (340 pages), which was favorably commented on by M. Eugene Morel, the great French librarian, who said it should be a model for French bibliographers. Mr. Pitt has also been engaged for some years preparing the Victorian section of the Australian Catalogue of Scientific and Technical Periodicals for the Advisory Council of Science and Industry.

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Mr. J. B. Trivett, an Associate Member of the Advisory Council, has retired from the position of Government Statistician of New South Wales after 41 years of public service. In 1912, Mr. Trivett accompanied the present Director of the Institute on a trip through Europe.

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Professor Maxwell Lefroy, on the recommendation of the Advisory Council, is being asked by the Commonwealth Government to reconsider his refusal to return to Australia to study the sheep-fly and other pests.

Dr. F. Stoward, D.Sc. (Birmingham), formerly Botanist and Plant Pathologist to the Department of Agriculture of Western Australia, has accepted a scientific position with Messrs. Penfold, the well-known vignerons of South Australia. Dr. Stoward's studies in bacteriology and fermentation at Birmingham University and the Pasteur Institute, Paris, render him specially well qualified for this work. During the period when thousands of people were inoculated weekly with the vaccine prepared at the Commonwealth Serum Laboratory, Melbourne, Dr. Stoward was assisting in its preparation.

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Mr. Gerald Lightfoot, M.A., has been appointed Head of the Information Bureau of the Institute, as well as Secretary. To enable him efficiently to carry on his dual duties, he will be relieved of routine secretarial duties.

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Professor Woolnough has been granted five months' leave of absence by the Senate of the Western Australian University to visit England and place the claims of the Western State before Messrs. Brunner, Mond, and Co. as the most suitable site in Australia upon which to establish the alkali industry.

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Dr. H. C. Richards, who has for some time acted as Honorary Secretary of the Queensland State Committee of the Advisory Council, has been appointed Professor of Geology of the Brisbane University. He was formerly lecturer on the same subject.

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Dr. T. Harvey Johnston has been appointed to the new Professorship of Biology at the Queensland University. Dr. Johnston was one of the Travelling Commissioners sent abroad by the Queensland Government to investigate the Prickly Pear problem. More recently he has been engaged on the Life History of Cattle Tick for the Institute.

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Mr. W. S. Robinson represents the Commonwealth Government and the Institute of Science and Industry on the newly-created Imperial Mineral Resources Bureau, of which Sir Richard A. S. Redmayne, C.B., is the chairman.

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Mr. J. T. Bull, the first secretary of the McGarvie Smith Institute, has left that institution and gone into business on his own account.

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Mr. C. S. Nathan, chairman of the Western Australian Industrial Development Board, and representative of the Western Australian Government on the Executive Committee of the Advisory Council, has been in the East consulting about the tick pest and the forest products laboratory project.

Tick-Resistant Cattle: Mr. Munro Hull's Claims.

By T. HARVEY JOHNSTON, D.Sc., and Miss M. J. BANCROFT, B.Sc., Biology Department, University, Brisbane.

In September, 1912, Mr. G. W. Munro Hull, of Eumundi, North Coast Line, called attention to the existence of a tick-resisting condition in a certain number of the cows forming his dairy herd, such animals remaining free from tick infestation, whilst the remainder were regularly attacked. He believed that this peculiarity was caused by the presence in such animals of some tick-destroying microbe, and that it was possible to convey the resistant quality to other animals by vaccination of the latter with some of the "lymph" occurring chiefly on the escutcheon of resistant animals. It was stated that such cows did not require to be sprayed or dipped since they remained sleek and clean-coated, whilst the untreated stock suffered from tick attacks. The vaccinated animals were liable to invasion by tick larvæ, but the latter nearly always died soon afterwards. Only on rare occasions did any reach maturity and lay eggs, but such eggs had not been found to hatch. Even when such animals were turned out into open country for months at a time, they maintained their resistance, whilst ordinary cattle under the same conditions became heavily infested, some dying of tick worry, even though food was abundant. Mr. Hull also suspected that the resistant condition was hereditarily transmitted.

The Agricultural Department purchased two cows, Clover and Tinkerbell (specially selected by Mr. Hull as examples of his resistant stock), in order to test the correctness of these claims. Since the latter were more specifically stated by him at a later date, we might briefly summarize the list published as a parliamentary report in the latter part of 1914.

(1) That these cattle never mature more than a few odd female ticks during the course of a year—a total of from 50 to 100 per year being the highest estimate, though the animals are regularly infested (naturally) by myriads of larvæ, the majority of which die while still very minute.

(2) That as a result of such freedom from developing ticks, these cattle do not require any attention as regards ticks, and may be turned out on any country for indefinite periods without experiencing tick worry, and, consequently, present a clean, sleek appearance.

(3) That this peculiarity is transmissible to other cattle by "contact" (*i.e.*, natural infection) and by vaccination, and is transmitted in every case to the progeny of such animals, but does not manifest its presence in the offspring until after the first year of life.

(4) That the material used for vaccination (*i.e.*, the exudate occurring on the escutcheon of resistant stock) is not produced as a result of excessive tick worry.

(5) That the comparatively few female ticks which are to be found maturing on such animals have become displaced without injury from other cattle, and have re-attached themselves to the resistant stock.

(6) That though these ticks may lay eggs, no larvæ develop from them, though eggs laid by ticks taken from control cattle readily hatch.

(7) That a few ticks are to be seen at odd times on resistant animals during winter when other cattle are free from them.

(8) That such animals have a markedly higher temperature than other cattle during winter.

In 1914 Mr. C. J. Pound, Director of the Yeerongpilly Experimental Station, as a result of his observations regarding the two cows purchased by the Government, reported adversely on Mr. Hull's claims. He stated:—

(1) That after having been placed in a ticky paddock for 27 days the two cows matured large numbers of ticks.

(2) And that they became so badly infested and tick-worried that dipping or spraying would have been justified.

(3) That he had not been able to transmit the alleged peculiarity to other cattle either by contact or by vaccination; while the calf of one of the two animals was commonly more or less heavily tick infested.

(4) That the exudation was caused by tick attacks.

(5) That cattle ticks only very rarely, and then with the greatest difficulty, re-attach themselves while maturing.

(6) That there is no difference in regard to the rapidity of hatching of eggs laid by ticks taken from the two experimental cows and those laid by ticks from other cattle.

(7) That there is practically no difference between the nature of the infestation of the so-called resistant animals and that of ordinary cattle during either the winter or summer months.

(8) That the difference in temperature reported by Mr. Hull did not occur.

It will thus be seen that Mr. Pound disagrees with all Mr. Hull's claims. The latter were in part re-stated in 1915 before the Select Committee of the Legislative Assembly, and another claim was added, viz.: that the application of an arsenical dip or wash temporarily suppressed the tick-resisting peculiarity.

Mr. Hull has recently modified, as a result of further observations, certain of his claims (Nos. 1 and 3 in this report) to a slight extent, and now states that the number of ticks (50-100) given as being carried per year by a resistant animal is, in many cases, excessive; that some of the ticks, in addition to the few that mature, instead of dying whilst very minute, as most of them do, continue to develop, but die before undergoing engorgement; that certain cases of apparent hereditary transmission has made its appearance in one case in a calf during the first year of life.

It appears to us that the most important points to be ascertained are:—

(1) Whether tick resistance actually occurs, *i.e.*, whether there are cattle which, when placed under conditions of natural infestation, do not become infested to the same degree as other animals similarly situated.

(2) Whether the degree of resistance is sufficiently marked so that very few, if any, ticks mature on such animals which, as a consequence, do not require dipping or other treatment to prevent tick worry.

(3) Whether resistance depends on breed, food, climate, &c.

(4) Whether the resistant condition (if present) can be transmitted in any way.

(5) Whether an exudation of serum or lymph occurs locally on resistant animals, and whether such is merely a form of tick sore.

Tick resistance might be manifested by—

(*a*) a failure to develop any ticks belonging to a particular species; such would be an example of tick immunity;

(*b*) a tendency towards light infestation when ordinary controls become heavily infested;

(*c*) a failure on the part of female ticks to become fully matured or engorged in such numbers as on controls when under the same conditions of climate;

(*d*) a failure of such engorged ticks either to lay a normal number of eggs or to lay eggs showing a normal percentage of hatchings.

In regard to (*a*), we know that some ticks are very restricted in regard to suitable hosts, *e.g.*, the cattle tick (*Boophilus australis*, and related species and varieties) thrives on cattle, and occurs naturally on horses and occasionally on sheep and certain other animals, but it is essentially a parasite of cattle. Other species are not so restricted, *e.g.*, various species of *Ixodes*, including our coastal scrub tick *X. holocyclus*. Some must leave their host to undergo certain stages of development, and then must re-attach themselves to some suitable host, which may belong to quite a different group of animals, *e.g.*, the red-legged cattle tick (*Rhipicephalus sanguineus*), which is occasionally found on horses, cattle, and dogs in south-eastern Queensland. The cattle tick, however, passes through all its stages on the one host animal. It is common knowledge amongst graziers and dairy farmers that there exists in many herds animals which are more or less resistant to tick invasion. For some reason, such beasts are distasteful to ticks, and, consequently, the larvæ either do not attach themselves, or else, having become attached, they only occasionally develop to maturity.

TICK-RESISTANT CATTLE.

We have interested ourselves in the question of tick resistance of cattle, and have endeavoured to collect all the information that we could regarding the condition. With this end in view we have visited a number of farms where resistant stock were to be found, and have given special attention to the animals which at present form, or previously formed, part of Mr. Hull's herd. We have inspected them on many occasions during 1915-18, while during the present year (1918) one of us accepted the offer of hospitality from Mr. and Mrs. Hull in order to make a detailed study of the cattle for a prolonged period (January, February, March and June), when all the engorged ticks to be seen on resistant animals were carefully collected, most of the cattle being examined both morning and afternoon, whilst the non-milkers were usually inspected once daily.

The following is the result of our thorough collecting from a number of resistant cows during a period of 27 consecutive days in the height of the tick season (January and February, 1918):—Cow No. 1, nil; No. 2, 3; No. 4, 3; No. 5, 2; No. 6, 0; No. 7, 4; No. 8, 13; No. 9, 0; No. 10, 30; No. 11, 16; No. 12, 0; No. 13, 1. Nine were taken from No. 14 in twelve days, and 64 from No. 15 in 27 days. The last animal is regarded by Mr. Hull as a non-resistant cow.

Nos. 7, 9, 14, and 15 are young animals. Excluding No. 10, only thirteen fully-matured ticks were removed from nine cows during the whole period, and even if we include No. 10, then the total is only 27. It may be urged that these figures only prove that ticks were extremely scarce on the property at the time, but that such was not the case was shown by the occurrence of fairly heavy infestation of a number of control heifers from another district, which were then being depastured with Mr. Hull's herd. No stronger evidence need be brought forward to prove the presence of a very marked tick resistance in these animals. Many others were carefully, but not so systematically, examined, and most of these showed the presence of resistance.

We have placed ourselves in communication, as far as possible, with those who have had any experience with Mr. Hull's stock, and have taken the opportunity to examine many of them elsewhere.

In practically all cases, the animals retained their resistance even when moved to other districts, provided that they maintained fair or good condition, and, as a consequence, did not require any treatment to prevent tick worry—in other words, under conditions of natural infestation, our observations have led us to agree with Mr. Hull's contentions numbered in this report as Nos. 1, 2, and 3.

It may be urged that departmental findings in regard to the two selected cows are exactly the opposite to our own. We have, as already stated, had Mr. Hull's animals under intermittent observation for three years and a half, and under the closest observation for a period greater than the normal parasitic period of the cattle tick. Mr. Pound's findings are, no doubt, correct when the animals were subjected to abnormal circumstances, *e.g.*, poverty of condition, intense artificial infestation, &c. When these same two animals were allowed their freedom under conditions which permitted only natural infestation, the published evidence associated with the names of Messrs. Corser and Walker, M.L.A., Chambers, Bates, and Butcher has satisfied us that Mr. Hull's claims were correct in regard to these two animals also. One of them, Clover, just before death became heavily infested, but this is only what one might expect, as, with old age, comes a lowering of condition and a lessening of resistance to any disease, including tick invasion.

Those who are interested in the matter are invited to peruse a somewhat lengthy communication on "A tick resistant condition in cattle" which is being published in the *Proceedings of the Royal Society of Queensland* (1918, p. 219). This article deals with tick worry; habituation of cattle to tick infestation; tick poison; tick resistance; conditions affecting such resistance; and the transmissibility of the peculiarity. All the evidence that we have been able to collect is there summarized.

We have carried out a series of observations with engorged ticks from resistant animals with a view to testing the fertility. We found that from the eggs laid by such ticks, the percentage from which larvæ were obtained was considerably smaller than in the case of ticks from control animals. The percentage of those whose eggs did not develop into larvæ was the same in both cases, whereas the percentage of partial fertility was much greater, and of practically complete

fertility was much less, than in the case of the controls. In other words, not only did very few ticks mature on such animals, but there was also some impairment of the vitality as shown by the lessened number of viable eggs (claim No. 8). We endeavoured to artificially infest a resistant animal to a moderate degree, but without success.

We disagree with Mr. Hull's opinion (claim No. 5) that the ticks on resistant cattle have developed on other animals and re-attached themselves to such resistant animals. In regard to the few ticks which Mr. Hull states (claim No. 7) are to be found in winter on such animals when other cattle are free, we believe the explanation to be as follows:—The cows which come under closest observation are the milkers, and, as a result of being in milk, such animals during winter frequently fall into somewhat low condition, which brings about a diminution of their tick-resisting powers. On the other hand, resistant cows, when dry, seldom become infested.

We took the temperatures of a number of resistant animals during the summer, and found them to be approximately normal. We think that a similar result would be obtained by registering the temperatures during the winter also (claim No. 8).

Last year we called attention to the presence of tick resistance in cattle, and invited correspondence regarding the effects of breed, food, dipping, condition, &c. A number of replies were received from various districts.

Brahmin cattle and crossbreds are more or less strongly resistant. In Queensland, tick resistance is not confined to any one breed, though, apparently, more common amongst Jerseys and Jersey crosses, perhaps on account of the presence of fine short hair and rather oily skin. Individual animals of various other breeds, Shorthorn, Ayrshire, Holstein, Hereford, and their crosses may possess a marked resistance. We are inclined to believe that it is, to some extent, a matter of individual idiosyncrasy. We think that food has an influence only to this extent, that animals in good condition are commonly less infested than those in poor condition. It may be urged that such animals are in good condition because they are not tick worried, but it is undoubtedly also true that an animal in good health is less liable to invasion owing to its natural resisting powers being then most marked.

Resistant animals have been noted in a number of localities extending from the Atherton tableland to Springbrook plateau, more usually in the vicinity of scrub country—perhaps the more abundant fodder in such situations helping to maintain condition and resistance.

Evidence has been collected in favour of, as well as against, the view that the application of arsenical solutions suppresses resistance. We are inclined to think that, provided the condition of the animals be not lowered by the treatment, suppresssion or diminution of resistance does not happen.

Transmissibility of resistance.—Mr. Hull claimed that it could be transmitted hereditarily, by vaccination, and by contact, *i.e.*, that it could be naturally acquired. Mr. Pound's observations did not uphold any of these claims.

We have carefully collected all the evidence available in regard to the herds of Messrs. M. and F. Hull (Eumundi), Mr. Inigo Jones (Crohamhurst), and others. As a result, we believe that resistance in certain cases is a quality capable of hereditary transmission. This does not mean that all progeny of such cattle will be resistant.

It is necessary to know how the parental stock acquired this peculiarity. We have not obtained sufficient information to allow us to state whether it is a Mendelian character. It is possible that certain cattle may really be "sports" as far as resistance is concerned, and, in such cases, the quality would be transmissible to a percentage of the offspring. We would like to obtain more information regarding the result of mating a resistant bull with resistant and non-resistant cows, so as to enable us to decide what part (if any) heredity plays.

There is considerable evidence in favour of the view that resistance can be transmitted to other animals by vaccination, *i.e.*, by using some of the exudate (to be referred to later) from resistant cattle. We have not succeeded in so transmitting it to any of our experimental animals.

Mr. Hull, when speaking of transmission by "contact," means to infer that the condition is picked up naturally by means of the larvæ which hatch from

eggs laid by ticks from resistant cattle, conveying "something" derived from such animals to those which they infest, and thereby setting up resistance. Our experiments were unsuccessful. We also failed to find in the exudate any organisms other than those whose presence resulted from contamination. In this we agree with Mr. Pound's findings. Moreover, there are many animals which have been on Mr. Hull's property in company with resistant animals for periods varying from one to seven years without becoming resistant.

We, however, believe that in most cases the condition is naturally acquired as a direct result of moderate, long-continued infestation, which causes the production of an anti-tick substance in the blood and other fluids of certain cattle. In other words, we believe that the tick actually inject minute quantities of a poison (tick poison), and this stimulates the blood (just as the injection of other foreign substances does) to manufacture an anti-tick substance which neutralizes the poison. We have found an anti-coagulin in the cattle tick, and it is known that similar poisons occur in several other ticks, which, on injection, give rise to various symptoms, but, if recovery occurs, then an immunity, or at least a resistance, follows.

We think that habituation is a step towards such resistance, and that the condition is slowly acquired as a result of tick attack. Some cattle-owners assert that if animals remain undipped for a season then the animals will either die of tick worry or else become resistant. This is, perhaps, correct, but in view of the greater probability of the former event happening, we think that dipping, in conjunction with a rotation of paddocks, should be systematically carried out, in order to control the tick pest and assist in its eradication.

Exudate.—Associated with tick resistance there may be an exudate (Hull's claim No. 4 in this report), which we have already described in the pages of the Queensland *Agricultural Journal* (May, 1918, p. 172). It consists of drops of a clear yellow fluid, which appear on the skin in various parts of the body, neck, dewlap, butt of tail, and escutcheon, notably on the last-named, where it is more evident owing to the shortness of the hair. These drops become thick and sticky, ultimately forming little granular masses of thin, flat, yellow scabs, according to the size of the original drop. The largest patches seen were about the size of a sixpence, or slightly larger. In some animals these little masses of exudate are perfectly clear, the skin appearing through them quite uninflamed. In others some blood may be present, and then the resulting scab is discoloured. When dry, these scabs are readily flaked off, leaving a rounded area of smooth, clean skin beneath. There is no positive evidence to prove that each patch of exudate is caused by the bite of a tick, though, occasionally larval ticks have been found attached to a dry scab, having become entangled in the sticky fluid. This exudation of lymph must be due to one, or both, of two causes—(1) either a slight mechanical injury to the tissue which, while not actually penetrating a blood capillary, allows an escape of lymph from the tissues—such might be caused by the larval tick inserting its rostrum, and then withdrawing it and going elsewhere; (2) or to an increase in the blood pressure, involving an extravasation of lymph from the capillaries. The formation of small, hard lumps on the flanks and in the vicinity of escutcheon and neck of resistant animals, upon the centre of which a patch of fresh exudate may or may not appear, would be accounted for by an increase in blood pressure, since when scored, blood flows very freely from such lumps. The affected area is rather irritable, the cows showing a desire to lick or rub the part. This exudation makes its appearance particularly during the warmer months (October to June), especially during the moist weather.

The condition just described appears to graduate into a type of tick-sore, so far only noticed on resistant animals. The scab formed over such a tick sore consists of two very distinct parts—an outer ring of a clear yellow substance, apparently composed of exactly the same matter as that spoken of above, surrounding a dark blood-stained core, on the upper surface of which there is a pit where the mouth parts of a tick have been inserted; while very often the tick is still present. Development up to the adult stage occurs in such ticks, but the females are unable to bloat, and remain stunted, sickly-looking individuals, eventually dropping off with the scab. The under surface of this hard black core, surrounding the rostrum of the tick, often contains pus. When such a scab is removed a corresponding pit is seen in the skin of the beast.

Although we have failed to find even larval ticks in the great majority of the patches of exudate examined by us—even after using the microscope, we believe that they are a direct result of larval tick attack on certain cattle, *i.e.*, cattle which possess some individual physiological peculiarity. Such animals are resistant, and apparently the small quantity of tick toxin—perhaps even the mere mechanical stimulus caused by the insertion of the rostrum—is able to so increase the local blood pressure that there is an exudation of lymph. We have already stated our opinion that the blood of resistant animals will be found to possess certain differences in regard to its biochemical composition.

It may be objected that this exudate makes its first appearance each season before the presence of ticks is noticed, but we must point out that larvæ begin to infest cattle some little time before their presence is noted by an ordinary observer.

We, then, agree with Mr. Pound in regard to this claim that the condition is the result of tick attack, but we disagree with him when he regards it as an ordinary tick sore. We agree with Mr. Hull that it is not the result of irritation caused by excessive tick worry.

The British people had ignored science, or at best held it at arm's length. Our policy of "muddling through" had covered almost every sphere of human activity. We prided ourselves on being a "practical people," and regarded science as a mere plaything for theorists. In the scheme of our great industries science was, until quite recently, treated as an Ishmael. Even now she was viewed with suspicion, yet to hope for success in modern industry without the aid of science was like attempting to navigate the trackless ocean without a compass.

—*W. M. HUGHES.*

Sheep-Fly Investigations.

REPORT OF SPECIAL COMMITTEE.

Mr. S. P. Fraser, Chairman of the Queensland Special Sheep-fly Committee, has forwarded the following report for 1918, signed by Mr. W. G. Brown, State Wool and Sheep Expert:—

In all, twelve specifics on 50 sheep each were tried out, and 107 used as controls and quite untreated. These specifics were all more or less poisonous. The attached analysis will give the details upon which some conclusions may be reached. These details are interesting, as, taken generally, they square with the operations at Gindie in a surprising way. Three hundred and sixteen sheep I did not see, yet the observations were taken.

In examining the sheep at shearing time, every animal was closely scrutinized by myself. Each mark was taken, and observations made and noted, as follows:—

Number of sheep, extent of infection, condition of fleece, number originally treated, number blown before treatment, number died of causes other than flies, number died of direct fly attacks, percentages.

It was unfortunate that nearly half of the experimental sheep escaped into a neighbouring paddock, during the last week before shearing, through the dam fence being broken. I could not, therefore, see, personally, all the numbers registered shorn. Mr. Taylor, the Entomologist, took that on his hands, and recently the whole number of sheep running in the experimental paddock were observed, and the notes on them sent along to your Committee. I have now the complete records of all the sheep treated and untreated, which ran in the experimental paddocks, sheep which were missing when I was at the shearing.

All who know anything of the matter, know that sheep dipped or dressed with any specific will be struck sooner or later. There is no such thing as a preventive against the attack of the fly; yet it is shown certainly that the attack on a dipped sheep is not nearly so serious as that on untreated sheep. For instance, 107 ewes were left untreated as controls, and 100 ewes were dipped in a well-known poisonous dip. The results came out 14 per cent. struck originally (20 animals) in the latter, 10 of which 20 were dried off before the maggots matured. In the controls which were untreated (107), 41 were struck, of which 16 were shown as having dried off. The percentage of striking in the controls was, therefore, 35.6 per cent. These results square approximately with the experience of the past five years at Gindie. There is thus shown a distinct protection, not only against fly attack, but in the effects of fly attacks.

Effects on Wool of Poisonous Dips.—The general appearance of the wool was very good, but, as this applies also to the untreated sheep, too much stress cannot be laid on the matter.

Number Treated.—The number treated was seven hundred and seven (707). Of these eleven (11) were known to be dead from various causes, only three (3) deaths being attributable to direct fly-attack. Several are still missing, but, no doubt, will turn up within a few days. Such analysis credits these sheep as being free from fly-attack until their fate is known.

Number Blown before being Treated.—When the sheep were treated, a number showed marks of having been attacked by flies before coming in for treatment. These animals were duly noted, and the different marks credited with such. Several others died from natural causes, parturition troubles, &c.

Nett Percentages.—The percentages range from 10 per cent. of attacks of all kinds up to 38 per cent., the latter result being expected more or less by all who dealt with the trials. The great bulk of the specifics, however, were well under the average for the whole flock, 26.87 per cent. gross. It must be remembered that the above figures are subject to revision and correction, and are given as progressive until the missing sheep are accounted for. An exhaustive report will then be issued.

The Seasonal Aspect.—Of course, the above trials have one great shortcoming, *i.e.*, the season has not been a bad one for flies. This is accounted for, however, by the extreme dryness hitherto experienced at Balmally. There is, however, sufficient evidence to warrant the further prosecution of experiments in the lines of dippings in poison.

Arsenic as a Dip.—One of the interesting experiments carried out was the use of arsenic and soda as a dip, in the strength of 0.4 per cent. per gallon of water. This dipping mixture showed an excellent record, only 16 per cent. being found struck in the fifty (50) sheep used. Of these, some were "dried off." The fleeces dipped in this solution were remarkably bright and clean. Yet I have a very strong prejudice against arsenic so strong as 0.4 per cent. being used as a dip mixture. The ordinary cattle dip must by law contain only 0.2 per cent. of arsenic. That is, half the above, and many cases of scalding and death have been observed in cattle. There is also a case on record of a well-known English formula which contains 0.32 per cent. of arsenic per gallon, and which had been used for many years successfully against the fly in Britain, causing serious losses in a flock which had been dipped. Further and extended trial is necessary in this case.

Washing with nearly Full Fleece.—A trial was made by washing the sheep in a liquor of soft soap and water. The appearance of the fleece later, on the shearing board, was distinctly worse than those of similar sheep. I think that experiment should not be persevered with.

Mice as Maggot Destroyers.—A report by Mr. C. J. Hare, the man in charge, shows that mice, which were so numerous up till recently, had devoured all the maggots in several sheep under his observation. The cure, however, was probably as bad as the disease, for the mouse plague destroyed much good fodder.

Chalcid Wasp as a means of Destroying the Maggots.—Mr. Taylor, Entomologist, was not many days on the ground before he discovered the presence of the Chalcid Wasp. This parasite on Blow-fly pupæ had been discovered in October, 1913, by Mr. Edmund Jarvis, Assistant State Entomologist, and hatched out in numbers in Brisbane. For various reasons nothing further was done in the matter, but in search for a means to control the blow-fly there is no doubt that it will be very useful. There is this to be said, however, in the district where Mr. Jarvis discovered the parasite—Longreach, Talleagrand, and Strathdan stations—at the very time the Chalcid Wasp was found to be very numerous, stations reported that up to 80 per cent. of sheep had been struck by flies, and it is a matter of common knowledge that flies were very troublesome for years afterwards.

It seems to me that undue stress is being laid in New South Wales on the efficacy of the Chalcid Wasp as an exterminator of the blow-flies. There is certainly undue misrepresentation by the daily and other journals in the south as to the investigations being carried out in Queensland. New South Wales problems and ours must differ, owing to the incidence of rainfall, which governs the blow-fly pest, being so different. We are tropical and sub-tropical, and have a distinct dry season (May to October) and a distinct wet season (December to April), wherein very heavy rain falls in three seasons out of six. It is, therefore, absurd for the scientist of the southern States to say "Queensland is asleep, and is just waking up." Queensland, for the past five years, has been working quietly and persistently on the problem, and is not without hope that a solution is in sight.

One use of physical science is that it gives definite ideas.

—SIR HUMPHRY DAVY.

Photo by Broothorn.

PROFESSOR ORME MASSON, C.B.E., M.A., D.Sc., F.R.S.

Vice-Chairman of the Advisory Council of Science and Industry.

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

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The Institute and the Universities.

The relationship of the Institute of Science and Industry to the Universities has of late been subjected to some sharp, though not over logical, criticism. It has been alleged on the one hand that the Universities are impractical, academic institutions, which, having obtained control of the Institute, are making it as impractical and academic as themselves. On the other hand, it is asserted that the Universities are quite exemplary bodies, whose good work is being impeded through lack of funds, and that lack of funds is in some way due to the existence of the Institute. Now, both charges cannot be maintained. They are mutually destructive. Either the Universities are good or bad. If they are good, then the closer the association of the Institute with them the better. If they are bad, then no harm can possibly come of their having an insufficiency of funds.

As a matter of fact, the criticism is based on a wholly inaccurate hypothesis. The Institute is in no wise "run" by the Universities. True, it works in co-operation with them, and is on the friendliest terms with them. They do not in any way regard the Institute as a rival. They are primarily teaching bodies; the Institute is primarily a research body—it employs graduates, it does not set out to make them. If it is successful, there will be a great stimulation on the science sides of the Universities. Hitherto these, apart from medicine, have tended to wane in Australia, in common with other English-speaking countries. The young man entering upon his academic career in the past has fought

shy of science. He could not see how he could make a decent living as a chemist or a biologist; but he could count—if he were smart enough—upon surviving if he became a lawyer or a medico.

Now, the Institute of Science and Industry hopes to alter all this. It hopes, through its persistent propaganda, to convince manufacturers and producers that science pays, and that the scientist is worthy of his keep. It hopes, however, not only to persuade individuals, but also corporations and Governments themselves. If it succeeds, the Universities will have more students, and those students will be better off when, having graduated, they enter upon the more serious part of their careers. After all, the Universities do not finish a man's life work, they only fit him to enter upon it.

How the coming of the Institute can be said in any way to endanger the Universities is beyond comprehension. The care of education, under the Constitution, is reserved to the States. The Institute is a Commonwealth activity. If the Institute ceased to exist to-morrow, thus relieving the Federal Treasurer of the necessity to provide a few thousands each year, not one penny of that money would be available to the Universities, which have to look—apart from private endowments—to the State Treasurers for the wherewithal for their upkeep.

All this is well recognised by the Universities themselves. The Institute is much indebted to the great seats of learning throughout Australia. In two States the Vice-Chancellors of the Universities are Chairmen of the State Committees of the Institute. On all the Committees are to be found University professors drawn from the Faculties of Science giving gratuitous services for the benefit of the Commonwealth. There is scarcely a Professor of Science in Australia who is not throwing his whole weight into the work being done by the Institute. There is not one University in which researches are not being carried out with funds supplied by the Institute, often with apparatus purchased by the Institute, in the hands of scientific workers maintained or partially maintained by the Institute. It would indeed be a sorry day when scientists ceased to work together.

Those, then, who assert that the Universities and the Institute are in any sense rivals are hitting wide of the mark. Instead, they are working harmoniously together, and the Institute is endeavouring to bring the Universities into closer touch than they have ever been before with the industrial life of the Commonwealth. So University professors and graduates sit on its councils side by side with great industrial leaders, the one mellowing the other by bringing differently trained minds to bear upon the self-same problems. In this way, it is conceived, can the best results be obtained for the people of this country.

One day the Institute will have laboratories of its own. Under existing conditions it is largely dependent upon the Universities. But the

Universities, though exceedingly willing, are not ideally placed for research work. This difficulty is quite recognised in other countries as well as our own. Dr. C. E. K. Mees,* in an article upon "The Organization of Industrial Scientific Research," recently wrote:—

> "Various schemes have been suggested for enabling the Universities to carry out research work of value to the manufacturers; but if it is believed that the work chiefly required for the development and maintenance of industry deals with the fundamental theory of the subject, it will be seen that this cannot possibly be carried on to any large extent in collaboration with a University; it requires a continuity of application by the same investigators over long periods with special apparatus, and with the development of special methods which cannot be expected from any University. This necessity for continuous work along the same line is, indeed, the greatest difficulty in making use of the Universities for industrial research. The conditions of a University laboratory necessarily make it almost impossible to obtain the continuous application to one problem required for success in industrial research, and, indeed, in the interests of teaching, which is the primary business of a University, such devotion to one problem is undesirable, as tending to one-sidedness.
>
> There are also difficulties in obtaining the co-operation of manufacturers with Universities, and in the application of University work to industry, which I see no hope whatever of overcoming; the Universities do not understand the requirements of the manufacturer, and the manufacturer distrusts, because he does not understand, the language of the professor. Moreover, it is quite essential that any investigator who has worked out a new process or material should be able to apply his work on a semi-manufacturing scale. so that it can be transferred to the factory by skilled men who have already met the general difficulties which would be encountered in factory application. This development on a semi-manufacturing scale is, indeed, one of the most difficult parts of research, resulting in a new product, and the importance of it is shown by the fact that all the large industrial research laboratories, however concerned they may be with the theory of the subject, have, as parts of the laboratory, and under the direction of the research staff, experimental manufacturing plants which duplicate many of the processes employed in the factory itself."

It is hoped that, as far as Australia is concerned, the Institute will soon be able to supply this defect.

When the Institute is full-fledged it will do the Universities another service of a highly valuable character, such as is performed by the

* Head of the Eastman Kodak Research Laboratory, Rochester, U.S.A.

Bureau of Standards in the United States. There the Universities, State and otherwise, carry on investigational work in many branches of science. In all these researches, especially in physics and chemistry, precision standards are required. Before the establishment of the Bureau—and this is the position in Australia to-day—an investigator was frequently required to spend more time in the preparation of the standards of measurement used than in the main work in hand. The Bureau has performed services of this character for practically every University in the country. These institutions are in constant correspondence with the Bureau in reference to standards, methods of measurement, values of physical constants, and the properties of materials, the latter especially in connexion with technical education. The Bureau's publications are to be found in the reference libraries of all the Universities and technical schools, and many of its publications are used in connexion with instructional work.

In quite another way is the Institute likely to aid the Universities. To-day in Australia skilled investigators are scarce. Only last month the Institute advertised for a man to investigate clays at Ballarat, and did not receive a single application. For the post of Science Abstractor with biological knowledge very few applications were received. This difficulty is likely to continue, so the Institute must take steps to build up its own staff. It has already communicated with the various seats of learning and ascertained what men are available for post-graduate research work. The idea is that the Institute will grant research scholarships to a limited number of such men for a year or two after they have graduated, so that they may be enabled to carry on research work under guidance, with the view of ultimately being absorbed either on the staff of the Institute or by industrial enterprises.

—F. M. G.

EDITORIAL

WASTAGE FROM COAL.

It is stated that by the consumption of raw instead of carbonized coal, the sum of £200,000,000 is lost annually to Great Britain. In other words, the value of the by-products which would be obtained by the economic treatment of coal, and which, under prevailing methods are dissipated, reaches this enormous sum. By failing to save the benzol, which would be sufficient for Great Britain's requirements, it is estimated that £20,000,000 is lost. A loss of 6,000 cubic feet of gas, suitable for the enrichment of illuminating gas or other purposes, is lost with every ton of coal burnt. Three times the present supply of electric power could be produced for sale at half the present unit were power production and distribution re-organized on a scientific basis. These are only a few of the items which it is estimated are wasted under the present methods of coal consumption. The wastage of large quantities of sulphate of ammonia, and of other valuable products, which form the bases of high explosives, dyes, paints, antiseptics, drugs, &c., are other items which stand out with startling prominence.

LOW TEMPERATURE CARBONIZATION.

To what extent this wastage can be averted by the adoption of different processes of consumption has, however, yet to be demonstrated. Cheap power and coal economy are still the subjects of inquiry by official scientific committees. Some interesting sidelights were recently thrown upon the trend of developments in Great Britain by Sir Douglas Mawson at a conference with the Executive Committee of the Advisory Council of the Institute of Science and Industry. He stated that it had been decided to proceed with the erection of a number of huge power stations throughout Great Britain for the supply of electricity. Already several private companies are engaged upon the low temperature carbonization of bituminous coal, under which the by-products are conserved and the coke is utilized for fuel. By this means high yields of tar and of benzol are obtained, and a smokeless fuel, excellent for steaming purposes and for home consumption, is produced. Sir Douglas Mawson also explained that a great deal of research work was being done along geological lines, as it has been found that certain coals yield much greater by-products than others. For commercial purposes these were first tested, and subsequently mixed in the required proportions. In South Wales there was a comparatively large industry in the manufacture of briquettes from coal dust, the dust being first washed and then mixed with pitch.

BLACK COAL ECONOMY COMMITTEE.

The opinion is widely held that in Australia, as in Great Britain, there is urgent need for the examination of the economic position arising from the existing methods of the distribution and consumption of black coal. Important fields for inquiry are suggested by the recent British investigations and developments, particularly the recovery of benzol, and the provision of cheaper power. After a superficial consideration of the subject, the Advisory Council of the Institute of Science and Industry has appointed a Special Committee to make detailed inquiry into the whole question of black coal economy. The members of that Committee are:—Professor Orme Masson (Chairman), Messrs. V. Anderson (Avery & Anderson), R. Bean (Chief Chemist, Victorian Railways), C. F. Courtney (General Manager, Sulphide Corporation), Colin Fraser (Managing Director, Broken Hill Associated Smelters), H. W. Gepp (General Manager, Electrolytic Zinc Co.), Essington Lewis (Assistant General Manager, Broken Hill Pty. Co.), A. McKinstry (British Westinghouse Co.), A. A. McIntosh (Works Manager, Metropolitan Gas Co.), C. N. Newman (Managing Director, Howard Smith Ltd.), and E. P. Grove (Merz & McLellan). This Committee will carry out such investigations as it considers necessary, and will report regularly to the Advisory Council of the Institute.

PROPOSED REVISED CLASSIFICATION OF IMPORTS.

In the early stages of the work of the Advisory Council of Science and Industry it was found that, owing to the unsatisfactory grouping and insufficient subdivision of imports of chemicals, it was often impracticable to obtain any reliable information regarding Australia's requirements. Information of this nature—as to the consumption of various materials and commodities—is, of course, of fundamental importance in connexion with proposals to establish new industries. A special Committee, consisting of chemical, statistical, and tariff experts, was appointed to draw up a revised list of chemical imports. The list was duly accepted by the then Comptroller-General for Trade and Customs, and came into force in August, 1917. The result is that the value of the returns has been enormously increased.

Similar difficulties have often been experienced in regard to other groups of imports, and a meeting of the Executive Committee was held to consider the whole matter, in consultation with Mr. J. Cuming (representing the Victorian Chamber of Manufactures), Mr. R. Cochrane (representing the Victorian Chamber of Commerce), Mr. S. W. B. McGregor (British Trade Commissioner), Mr. E. T. McPhee (representing the Commonwealth Statistical Bureau), and Mr. Stirling Taylor (Director, Bureau of Commerce and Industry). All those present were strongly in favour of steps being taken to extend the system of reclassification on a scientific basis, so as to cover the whole list of imports. It was decided that the same procedure should be followed as in the case of chemicals, and that a number of committees, each consisting, if practicable, of a manufacturer, an importer, and a statistical and tariff expert, should be appointed. A Central Committee was also appointed to make the necessary arrangements for the organization of the work of the sectional Committees, the co-ordination of their reports,

and the consideration of the machinery to give effect to the new classification lists. The members of the Central Committee are as follow:—

Mr. Robert Cochrane, representing the Victorian Chamber of Commerce; Mr. S. W. B. McGregor, British Trade Commissioner; Mr. E. T. McPhee, Commonwealth Statistical Bureau; Mr. R. A. Pryor, representing the Victorian Chamber of Manufactures; Mr. A. B. Piddington, Chief Inter-State Commissioner; Mr. Stirling Taylor, Director, Bureau of Commerce and Industry; Dr. F. M. Gellatly, Director, Institute of Science and Industry; and Mr. G. Lightfoot, Secretary, Institute of Science and Industry.

SIMILAR MOVEMENT IN ENGLAND.

Through the courtesy of Mr. S. W. B. McGregor, British Trade Commissioner, we have received a copy of a communication addressed to the Federation of British Industries, which makes it clear that a movement in the direction of reclassification of trade statistical returns is afoot. This will apply both to import and export statistics of the United Kingdom, as contained in the Monthly and Annual Statements of Trade. It appears to the Board that the present is a fitting opportunity to make such changes as may appear necessary in order to increase the utility of these statistics to the commercial and industrial community.

CANADIAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

This Council, which was established in 1916, has already accomplished a considerable amount of useful work. It has recently branched out in a new direction, which is likely to have an important bearing on the development of industrial research. It has instituted studentships and fellowships for scientific and industrial research at the Universities in the Dominion. The studentships, which are post-graduate, and are open to both men and women, are intended for those who have given distinct evidence of capacity for original research, to enable them to continue the prosecution of science with the view to aiding its advance or its application to the industries of the country. The principal work of the holder of a studentship must be a research in some branch of science the extension of which is important to the national industries, and the departments of science in which capacity for reseach will be accepted as qualifying for a studentship are: Biology (economic), chemistry, engineering, geology, metallurgy, mineralogy, and physics. The studentships are of the value of £120 for the first year, and £150 for the second year. The research fellowships are only awarded to those who, either through previous tenure of a studentship, or otherwise, have shown a high capacity for research on some problem the extension of which is of importance to the national industries of Canada. They are of the value of £200 for the first year, and of £240 for the second year, if the Advisory Council should decide to extend the fellowship over two years.

PRICKLY PEAR FUNGUS.

The Institute has received from Mr. C. French, junior, Entomologist, Victorian Department of Agriculture, specimens of prickly pear infested with fungi. The pear was found growing at the Race-course, Williamstown. Mr. C. C. Brittlebank, Plant Pathologist, Department of Agriculture, has examined the fungus, and reports that it agrees in all particulars with *Hendersonia opuntia*, Ell. et Ev., except in the size of the spores, which are smaller, being 12—16 × 4—4½ mm., as against 20—25 × 4—5 mm. of the named species. The difference in the measurement is, in Mr. Brittlebank's opinion, sufficient cause to constitute a new species. The injury to the prickly pear is confined to the surface, and is caused more by the blocking up of the stomata than by injury to the plant cells. In cases of bad attack the whole surface becomes covered with a layer of corky tissue, and this, in conjunction with the plugging of the stomata, checks respiration and cuts off the light, thus causing, in time, the death of the part attacked.

MANGROVE TANNING.

The Special Committee at Brisbane has completed its experimental work. A successful method of overcoming the decolourization problem has been devised, and it is hoped to include in the Committee's final report, now in course of preparation, a sketch plan of a plant for carrying out the process, with estimates of working costs.

ENGINEERING STANDARDIZATION.

The Institute has been pleased to receive from the Victorian Advisory Committee of the Institution of Civil Engineers an offer to assist in the work of engineering standardization. It is well known that the Institution of Civil Engineers in London has taken a leading part in the establishment and work of the British Engineering Standards Association, which was formed in 1901 as the Engineering Standards Committee by the Institutions of Civil Engineers, Mechanical Engineers Naval Architects, and Electrical Engineers, and the Iron and Steel Institute. The whole question of establishing a Commonwealth Engineering Standards Association has been further considered by the Executive Committee, which has decided that the secretary, Mr. G. Lightfoot, shall visit each State, with a view to getting the States and various interests into line, and to promoting the formation of a Federal organization to take up the whole question.

PAPER PULP.

In Bulletin No. 11, "Paper Pulp: Possibilities of its Manufacture in Australia," information was given regarding the results of experimental work in the pulping qualities of certain eucalypts, especially young karri trees. Proposals are now on foot for the erection of a pulping plant for the manufacture of news printing paper and brown paper in Western Australia. It is intended to establish the plant in the vicinity of timber mills, and to utilize the jarrah refuse for pulping purposes.

UTILIZATION OF SPENT MANGROVE BARK.

In connexion with the investigational work on mangrove tanning, a request has been received as to the suitability of the spent bark for use in corroding work in the manufacture of paint. Messrs. Lewis Berger and Sons (Australia) Limited, Sydney, are desirous of carrying out researches on this matter, and arrangements have been made for the Special Committee in Brisbane to supply that firm with a parcel of the spent bark for experimental purposes.

MAGRAMITE.

A large number of inquiries has been received, both from Australia and abroad, for information regarding the manufacture of magramite, the synthetic resin varnish devised by the Special Committee on Tin Plate Substitutes. Firms in Holland, Switzerland, and America have written for information, with a view to acquiring the manufacturing rights for their respective countries.

COPRA DRYERS.

The Institute has received copies of reports by Major J. J. Cummins, Chief Surveyor, Rabaul, on copra drying plants. The reports are accompanied by plans and conclusions reached by Major Cummins, who, in his spare time, has gone to a considerable amount of trouble, and devoted much care, to this proposition. In order that the report and plans may be available to any Australian planter requiring information on the matter, the Institute has recommended that they should be printed.

BULLETINS.

Bulletins are in the hands of the printers dealing with prickly pear, cattle tick, and Posidonia fibre.

STANDARDIZATION OF WHEAT.

The Seed Improvement Committee, which is at present engaged in getting out standard specimens of types of wheat, has up to the present had its head-quarters at the National Herbarium, South Yarra. Unfortunately, owing to lack of proper storage accommodation at the Herbarium, a quantity of the material sent in from the several State Departments of Agriculture has been destroyed by mice. A grant has been made for the purchase of vermin-proof cupboards, and when these are available, temporary accommodation for the Committee will be found at the offices of the Institute.

POSIDONIA FIBRE.

Professor J. Read and Mr. H. G. Smith have completed a thorough investigation of a fundamental nature on Posidonia fibre. Results of much interest and value have been obtained, especially in regard to processes for rendering the fibre less brittle, and, therefore, more suitable for textile purposes. The results of the investigations will be published at an early date as one of the Institute's Bulletins.

CATTLE TICK ERADICATION IN WESTERN AUSTRALIA.

The Committee in Perth has held several meetings, and has practically completed the drafting of a scheme for driving back the cattle tick pest from the pastoral properties along the main stock routes. It is proposed that the work should be carried out on a contributory basis of £1 for £1 by the Commonwealth and Western Australian State Governments.

UTILIZATION OF KELP.

The Committee in Tasmania has completed its investigations, and is engaged on the preparation of its final report. Among other things it has discovered a new product obtained by precipitation of the organic matter. The moist precipitate can be pressed into any convenient form and then hardened by treatment with formalin. It turns perfectly in the lathe, and takes a high polish. It is suitable for the manufacture of buttons and other small articles, and for insulators for electrical purposes.

CLAYS IN WESTERN AUSTRALIA.

A further progress report has been received from the Special Committee which is investigating the clays of Western Australia. The report gives particulars of a number of clays tested in connexion with the pottery experiments. Some of the clays were found to be especially suited for chemical and sanitary ware, some for the manufacture of porous battery jars, and some for white earthenware. Others were particularly suitable, when mixed with granitic fireclays for the manufacture of many classes of refractories. Some of the clays were, however, found to be of but limited utility, such as the manufacture of porous butter-coolers and cheap glazed jars for use as food containers of various kinds. Others again were found to be particularly good for special purposes, such as for use in Portland cement making and roofing-tiles.

FERRO-ALLOYS.

Investigations have so far been carried out on the manufacture of ferro-chrome and ferro-tungsten, the most important alloys in the manufacture of high-speed tool steel. It has been shown that there is no difficulty in manufacturing ferro-chrome at a reasonable cost, providing that a cheap source of electric supply is available. Ferro-tungsten containing over 80 per cent. of tungsten has been made by reducing wolframite ore by means of carbon, without the addition of any iron or oxide of iron. A satisfactory method of preparing tungsten powder free from carbon has also been devised.

THE SPARROW PEST.

Captain S. A. White, Adelaide, Past-President of the Royal Australasian Ornithologists' Union, is supervising the steps which have been taken by the Institute to prevent the spread of sparrows to Western Australia. Some time ago, the Institute made inquiries and ascertained that sparrows had reached Tarcoola, along the route of the East-West Railway, and that they had also travelled along the coast and had been

seen at Eucla. Recent reports from Tarcoola indicate that the birds arrive at that place at frequent intervals. Captain White has made the necessary arrangements to prevent the spread of the birds, which are shot from time to time, as they arrive. The sparrows seen at Eucla have also been destroyed.

MODE OF OCCURRENCE OF GOLD.

Investigations of an exhaustive nature are being carried out on the Bendigo gold-fields. Their main object is to determine the principles which have caused the erratic localization of the gold shoots in the quartz reefs, and thus, among other things, to cheapen the cost of deep prospecting. The results of the first two years' work have been published in bulletin form, and have aroused considerable interest among mining men and geologists. Some of the conclusions are not only of local application, but have an important bearing on the genesis of auriferous ores in other gold-fields.

SCIENCE AND WAR.

Lieutenant-Colonel (Professor) David, C.M.G., D.S.O., replying at the annual meeting of the Royal Society of New South Wales the other night to words of welcome upon his return from the Western Front, said that science had played a far more important part in the war than any one would imagine from the small hints that had been dropped from time to time. For obvious reasons, the War Office and the Navy had kept to themselves many of the most recent types of scientific discovery; but it was a simple hard fact that science had played an enormous part in the winning of the war. "It is up to each one of us, as scientific men," proceeded Colonel David, "to see that the importance of science for national existence, whether in peace or in war, is properly appreciated by the public, and that scientific research finds its proper place in the history of this great Commonwealth." One was too apt to forget, he added, the importance of science in the storm and the stress of war. It was proposed in the Old Country, for instance, to appoint a certain able scientific man to conduct research on lines which would be useful both in peace and in war; but as soon as the League of Nations was drawn across the trail it was stated, in effect:—"Well, you see, the League of Nations will make big wars impossible, and, after all, is the expenditure on a scientific bureau really justified?" There was the tendency. They had seen it already in the Old Country.

LEGUMES AND OIL-YIELDING SEEDS.

Mr. Edwin Cheel, of the Sydney Botanic Gardens, some time back wrote to the Institute suggesting that it should give assistance towards the cultivating and testing of a number of legumes and pulses, together with a list of oil-yielding seeds. On a definite proposal being asked for as to the manner in which such assistance should be rendered, Mr. Cheel replied that, in regard to—

(*a*) Pulse or other leguminous crop plants, the work should be carried on by a practical man possessing a fair technical

knowledge of the plants he is dealing with. In many instances certain crop plants are abandoned through failure of first trials, and it is necessary to persevere with their cultivation in order to secure acclimatised stocks. Successful results have been obtained by Mr. Cheel in the acclimatisation of the soy bean, the black Mauritius bean, and the Jerusalem pea.

In regard to—

(*b*) Oil-yielding seeds, skill was required to grow them successfully. For instance, certain plants might be satisfactory so far as growth was concerned, but gave very poor crops of seeds. This might be due to lack of pollination, as in many instances the plants were diœcious. During the early stages of the work a good deal of it could be done in conjunction with various experimental farms under State control, and in the different Botanic Gardens.

Mr. Cheel would be willing to render every assistance, and suggested that the Under-Secretary for Agriculture be approached with a view of securing his co-operation, and that monetary assistance be granted to extend the work to other States.

The plants mentioned included black Mauritius bean, China velvet bean, fleshy-podded velvet bean, Florida velvet bean, velvet bean, Yokohama bean, soy bean, cow peas, climbing French or kidney beans, flageolet beans, maize or corn oil, coconut oil, hemp-seed oil, colza or colza rape oil, Indian rape oil, soy bean oil, peanut or ground nut oil, flax or linseed oil, castor oil.

The matter was carefully considered by the Executive Committee, which was of the opinion that the problems involved in the successful cultivation of these plants are more economic than scientific. Most, if not all, of them could be cultivated in Australia, but not on a commercial basis in competition with the cheap labour products of other countries.

SOUTH AFRICAN BOARD OF INDUSTRY AND SCIENCE.

In 1916, the South African Government appointed an Industries Advisory Board, consisting of business men, representative of commerce, manufactures, and labour, and in the following year, on the recommendation of that Board, a Scientific and Technical Advisory Committee was established to deal with all scientific and technical matters and questions of research. The Advisory Board and the Scientific and Technical Committee have now been amalgamated, under the title of the South African Advisory Board of Industry and Science, and a Committee of the Board, under the title of the Research Grant Board, has been established to advise on research in Universities and cognate matters.

MEDICINAL HERBS AND PERFUMES.

Two of the subsidiary agricultural industries which have by no means reached their full stage of development in Australia are the culture of medicinal plants and the extraction of perfumes. At an early date, their commercial possibilities will be more fully and thoroughly tested. Two members of the A.I.F., Captain G. Adcock and

Lieut. C. H. Blumer, intend to undertake this task. Both are organic chemists and engineers, and with developmental work in view are now in Belgium studying the latest methods. Captain Adcock writes:—"We have studied and are studying the latest methods at Grasse, and before our return will have had considerable experience, besides passing through a school of herb-growing in England." He hopes from research work he and Lieut. Blumer are engaged upon to soon get some useful results from essential oils in the matter of dyes.

BROWN COAL IN GERMANY.

Lieutenant-Colonel (Professor) David, having visited the brown coal fields of Germany, states—"The Germans have devised a very clever arrangement of furnace construction, disposition of firebars, and control of the hot gases of combustion, so as to secure the absolute maximum of efficiency and power. The drawback presented by the presence of so much water in the coal is overcome by allowing the coal to travel slowly down inclined chutes, where, by the operation of hot gases, the moisture is extracted before the coal reaches the furnace. Nothing is wasted, for the gases used for desiccating the coal are re-admitted to the furnace. The steam generated acts direct on the largest turbines I have ever seen. The turbine shaft drives a generator which produces 50,000 kilowatts. I saw several of these large turbines at work in one great engine-room. It was a most impressive sight, and in view of the difficulties of handling this brown coal material, which so many nations would have neglected to use altogether, I cannot help wondering how it has been given to us to conquer a people which had mastered so difficult a problem and applied the highest principles of science to the full utilization for arts and manufactures of this natural product."

PRODUCTS OF SEAWEED.

"For the past few years," says *Nature*, "Swedish seaweed has been coveted by the Germans, who, by chemical treatment, made it into fodder, and also extracted valuable chemical products from it. A number of experiments have been made at Stockholm, according to the *Svenska Dagbladet* for 12th May, and it has been found that by dry distillation of 1 kg. of dried seaweed the following substances can be extracted:—30 to 32 litres of illuminating gas, 43 per cent. of carbon, 45 per cent. of distillates (acetic acid, methylated spirit, formic acid, acetone, &c.), 14 per cent. of salt (sodium sulphate, potassium sulphate, potassium chloride), also iodine, bromine, a very aromatic tar product, and carbolic tar (creosote)—an excellent preservative of timber. A factory is about to be started by the Focus Co. to take up the conversion of seaweed on a large scale."

EUCALYPTS IN EUROPE.

Dr. L. De Launay, in the issue of *La Nature* for 18th May, describes the efforts of a French company to cultivate the eucalyptus and pine on a large scale in the Penarroya district of Spain (on the borders of Cordoba and Ciudad Real) for the production of paper pulp. At first, the geological conditions of this region were not considered favorable

for intensive afforestation, but experiment showed that the two woods mentioned would yield satisfactory results under proper treatment. The results are justifying expectations, and it is hoped that the once barren region will in a few years repay the time and money spent in developing it. The wood will be used for pulping, pit-props (there are mines near), and for the distillation of acetic acid, &c.

An Inter-State Structural Steel Standardization Conference has been convened by the Director of the Bureau of Commerce and Industry for 1st July, in Melbourne.

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Hon. Walter Kingsmill, M.L.C., Chairman of the Plant Acclimatisation Committee, has forwarded sample of cotton grown by Mr. C. C. Lawrance, of Bruce Rock (Western Australia), in a rainfall of 3.65 inches. The cotton grew to an average height of 2 feet, with an average of 18 bolls.

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A proposal has been made that the Institute should endeavour to arrive at a standard specification for cement throughout the Commonwealth. The matter is now under consideration.

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Considerable difficulty has been experienced in obtaining the services of a qualified man to carry out research work into white clays at Ballarat.

If we are to prove ourselves fittest to survive in this great struggle we must walk with science hand in hand. We must seek its aid in order to achieve victory, we must enlist its services in order to prepare to meet the conditions which will arise after the war.

—W. M. HUGHES.

EXPERIMENTAL WORK IN PROGRESS.

Life History of Cattle Tick. This is being carefully followed up by skilled investigators at the University grounds in Brisbane, and at experimental stations at Woolooga and Toowoomba. The main object of the work is to determine the length of time taken by the tick to pass through its different stages. This has an important bearing on the question of quarantining infected animals.

Sheep-fly Pest. Investigational work is being carried out at Wooloondool, near Hay, in New South Wales, and at Dalmally Station, in Queensland, and large numbers of parasitic wasps, which destroy the pupæ of the sheep-fly, are also being bred and distributed. The New South Wales and Queensland Governments are co-operating.

Castor Oil Beans. Forty acres are being grown in an experimental way at Cockatoo, in Victoria. Different varieties are being tested for productivity and oil content, and seeds are being collected in Queensland for further experiment next season.

Utility of Clays. A large number of different samples of clays are being tested at the Geological Survey Laboratory, Perth, in order to discover which of them are most suitable for industrial purposes. Much valuable assistance and advice is being given to persons engaged in the industries concerned.

Worm Nodules in Cattle. An endeavour is being made at an experimental station at Kendall, New South Wales, to discover the means by which this disease is transmitted. Valuable progress has been made, and if the experiments prove successful, it may be found possible to control the spread of this disease.

Cattle Tick Dips. Investigations are being initiated in Sydney into cattle tick dip formulæ, and the effect of different dips upon the cattle treated. The New South Wales State Government is co-operating and bearing half the cost.

White Ant Pest. The New South Wales Department of Agriculture is co-operating with the Institute on a £1 for £1 basis in an endeavour to prevent or minimize destruction by white ants.

Forest Products. The Institute is working with the New South Wales Forestry Commissioners on research work connected with forest products, each authority bearing a moiety of the cost.

White Earthenware. Clays likely to be suitable for the manufacture of white earthenware are being tried out at the Ballarat School of Mines at the expense of the Institute, which is also providing portion of the necessary plant.

Posidonia Fibre. Exhaustive tests have been conducted by the Institute in co-operation with Sydney University and the Sydney Technological Museum as to the economic value of this marine fibre, which is found in large quantities round the coasts of South Australia. Valuable results have been obtained, and a report of the work is in the printer's hands.

Grass Tree. At the Adelaide University Chemical Laboratory investigations are in progress with a view to the commercial utilization of this plant.

Seed Improvement. Scientific researches are being made calculated to lead to an improvement in the seed sown in the Commonwealth for the cultivation of cereal crops. The actual work is being done in each of the chief agricultural States.

Mechanical Cotton Picker. Initial laboratory tests have been completed, and a machine on the suction principle has been constructed with a view to carrying out a larger scale test. The most suitable varieties of cotton for harvesting by mechanical means are now being grown in Queensland. Dry weather, however, is likely to cause the loss of a season.

Redgum as Tanning Agent. Kino from the Western Australian redgum is being experimented with at the Perth Technical College and at a local tannery.

Standardization. Preliminary work has been carried out both as regards standardization of electrical power generating and distributing systems and structural steel sections. The latter work is being done in co-operation with official bodies in England. Steps are being taken with a view to the formation of a Commonwealth Engineering Standardization Association.

Imperial Mineral Resources. Negotiations are now proceeding between the Institute and the Imperial Mineral Resources Bureau which are likely to lead to the Institute's undertaking the work of compiling a survey of the mineral resources of the Commonwealth. This work is being carried out as part of the Imperial War Reconstruction.

Catalogue of Scientific Periodicals. A catalogue embracing the whole of the scientific periodicals to be found in the various libraries of the Commonwealth is now almost completed, and will be published for the benefit of scientific workers.

Electrical Sterilization of Cream and Milk. A direct current is to be applied to ripened cream, and milk is to be sterilized in thin sheets by actinic rays. The work is being done at the Randwick Tramway Workshop.

Weights and Measures. A Committee is inquiring into the whole question of the Acts and regulations in force in the several States relating to weights and measures, with a view to bringing about some degree of uniformity, which is essential for proper development in the local manufacture of certain weighing and measuring machines.

Power Alcohol. Experiments are being carried out at Melbourne University Engineering School to test the efficiency of alcohol as a fuel in different types of internal combustion engines.

Mangrove Tanning. Investigations have been carried out at Brisbane, and a successful method of overcoming the decolourization problem has been devised. The Committee is preparing specimens of mangrove tanned leather, and is completing the preparation of its report.

Road Materials. A Special Committee has prepared an outline of a scheme for the organization of a Commonwealth laboratory to carry out experimental research on road materials and on standardization of methods.

Kelp. The question of the commercial utilization of kelp is being investigated at Hobart. The main products obtainable are potash and iodine, but a new product has been obtained, which can be turned in a lathe and polished, and is suitable for making insulators, buttons, and various other articles. The Committee is engaged in preparing its final report on the work.

Native Grasses and Fodder Plants. An Inter-State Committee is at work with headquarters at Sydney on the collection, propagation, improvement, and cultivation of the most promising indigenous grasses and fodder plants of Australia.

Fuel Economy. A Committee has been appointed to make recommendations as to what steps should be taken to promote a more economical utilization of fuel, especially of black coal, in Australia.

Bureau of Information. The nucleus of a scientific and technical library has been established, and every week a considerable number of requests for information is being received and dealt with.

Improved Tanning Processes. Systematic experimental work is being carried out by the Institute at Sydney with a view to the determination of a standard and scientific method of tanning under practical conditions.

St. John's Wort. The Imperial Bureau of Entomology, London, is carrying out preliminary investigations for the Institute on the subject of insects which feed on and destroy St. John's wort.

Viticultural Investigation. In collaboration with authorities at Mildura and Merbein (Victoria) and Curlwaa (New South Wales). the Institute has initiated systematic experimental work into pathological and entomological problems, and into various physical and chemical questions relating to cultivation under irrigation.

Prickly Pear. A complete scheme for investigating the question of the destruction of prickly pear by insect enemies has been formulated and approved by the Commonwealth and Queensland Governments. It is hoped that the New South Wales Government will come in at an early date.

Cotton Growing. Parcels of seed of the most suitable varieties of cotton for cultivation in Australia are being obtained for experimental purposes from the United States of America Bureau of Plant and Industry, Washington.

Papua. Steps are being taken for the formation of a Papuan Development Committee as a branch of the Institute, with a view to the development of that territory's resources.

Phosphatic Rocks. A Special Committee has been appointed to investigate the local phosphatic rocks of Australia, particularly with a view to the discovery of means for increasing their "availability," as well as to determine their actual value as fertilizers in an untreated condition.

Laboratories. A large amount of attention and time has been devoted to the consideration, in a preliminary way, of the laboratories to be established when the bill for the permanent Institute is passed.

Cattle Tick in Western Australia. A Committee in Western Australia, representing the Commonwealth and State Governments, as well as pastoral interests, is completing the formulation of a scheme for the eradication of the cattle tick in that State.

Ferro Alloys. Experimental work is being carried out at Melbourne in regard to the methods of manufacture of the most important ferro alloys, especially those used in the manufacture of high-speed tool steel.

Bendigo Gold-fields. Investigations are being carried out to determine the principles which have caused the erratic localization of the gold shoots in the quartz reefs, and thus, among other things, to cheapen the cost of deep prospecting.

Alcohol Engines.

STARTING FROM COLD: THE PROBLEM SOLVED.

By W. N. KERNOT.

One of the first matters to which attention was given by the Special Committee on Alcohol Fuel and Engines was a thorough examination of all available literature and reports on previous investigations and tests which had been carried out in Europe and the United States of America on the use of alcohol as a fuel. These reports showed that one of the greatest difficulties which had prevented the more general adoption of alcohol as a liquid fuel was that internal combustion engines could not be started from cold on alcohol, that is to say, some preheating device was necessary, or else the engine had first to be started and warmed up with some other fuel, and then switched on to alcohol.

In the early stages of its work the Committee was inclined to the view that the engine problem was the most important question to be solved before alcohol could be utilized in Australia extensively as a liquid fuel. It appeared that if an engine could be devised to start and run efficiently on alcohol, the other problems, *i.e.*, the production of the alcohol and its denaturation, would be readily solved. The experiments which have been carried out show, however, that the engine problem is a small one compared with the questions of the production of alcohol on a large scale and of its denaturation.* Not only has it been thoroughly demonstrated that alcohol can be used successfully in internal combustion engines, but it has also been proved beyond doubt that the difficulty of starting from cold has been overcome in a simple and effective manner.

According to the information given in the reports of the experiments in other countries, all previous investigations in connexion with the utilization of alcohol as a power-fuel in internal combustion engines were carried out in engines having initial cylinder compressions of from 60 to 200 lbs. per square inch. The available data and records of the experiments failed to show that any field, either above or below that range of pressures, had ever been explored. Tests were made with various types of engines at Melbourne University and at Messrs. H. V. McKay's works at Sunshine. Mr. Ralph McKay found that, though the engines could not be started from cold on alcohol, the unexploded charge issuing from the exhaust could be ignited with a hot bar of iron or the flame of a candle. This fact, taken in conjunction with the fact that the reports on previous investigations in other countries indicated that no research had been done with pressures below 60 lbs., provided the incentive for prosecuting investigations below that pressure.

For the purpose of the investigations, a single-cylinder engine, having a bore of 3 inches and 3½-in. stroke, was selected. The connecting rod was adjustably arranged to provide a means of shortening or extending, in order to obtain any desired degree of compression, the

* See Bulletin No. 6—" Power-Alcohol: Proposals for its Production and Utilization in Australia."

intention being to work from 60 lbs. per square inch down to atmospheric pressure. The engine was equipped with a high-tension magneto, and, instead of using a carburettor, the engine was primed through the priming valve on the top of the cylinder. In all the experiments, ordinary methylated spirit was used.

The compression was gradually reduced, and attempts were made to fire the charge. The first indication of any success was a muffled explosion at 43 lbs. compression. At 37 lbs. compression the engine gave some distinct explosions, and at 34 lbs. fired regularly. The best results were obtained between 35 and 25 lbs. per square inch compression. Subsequently, it was found by further experiments that the best way to reduce the compression was to control the admission of the air without altering the length of the connecting rod.

POWER-ALCOHOL: STARTING DIAGRAMS.

(Kelly and Lewis Engine, 4¾-in. x 6-in.)

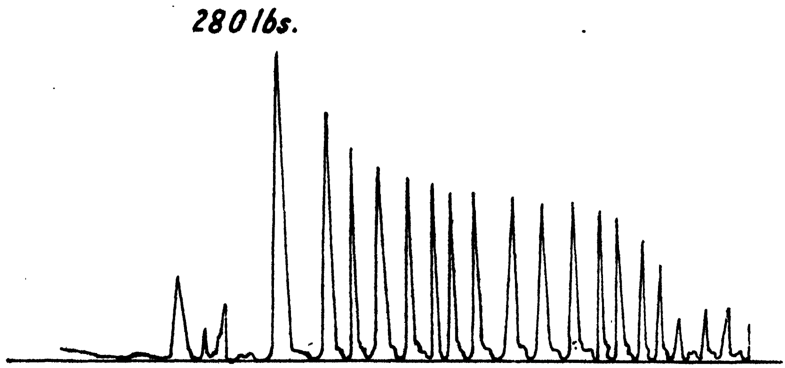


Diagram 1.—Priming Charge, 5cc. Alcohol.

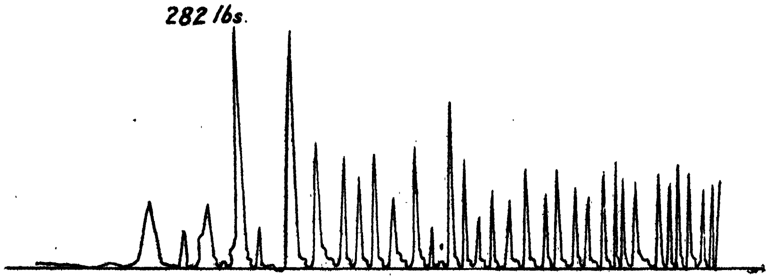


Diagram 2.—Priming Charge, 10cc. Alcohol.

The next test was made with a four-cylinder tractor engine, having a 4½-in. bore, 5½-in. stroke. In this experiment a plug was placed in the air-intake pipe. The engine, being primed with alcohol and cranked in the usual manner, started easily.

A further trial was then made with a 25 horse-power Vauxhall car equipped with a White and Poppy carburettor. A leather disc was placed over the air intake on the carburettor, the engine was primed with methylated spirit through the priming cocks, and, by cranking, the four cylinders were started without difficulty. This was all

accomplished in the space of a few minutes. The engine in this car was then primed with whisky, and also started, but it was found that it did not run regularly. For a road test, a tank for carrying the methylated spirit was placed on the car and connected to the carburettor. The leather disc was punctured to allow sufficient air to be drawn to procure the correct mixture. Although this arrangement was of a rough nature, it served the purpose readily, and a satisfactory run for a few miles was obtained.

Since the above experiments were carried out, tests have been conducted, through the courtesy of Professor Payne, at the Engineering Laboratory, Melbourne University, on starting commercial petrol engines on alcohol from cold, with the following results:—

(*a*) "Kelly and Lewis" engine (made in Melbourne), single cylinder, 4¾-in. bore, 6-in. stroke, fitted with Zenith carburettor, magneto ignition, speed 570 revolutions per minute, four-stroke cycle, about 6 B.H.P., with water cooling. This engine was regularly started from cold on 70 consecutive mornings without fail at the first attempt, the atmospheric temperature being as low as 9 deg. C.

(*b*) Other engines started from cold include the following water-cooled makes:—"Sunshine," "Ford," and "Perry," and the following air-cooled types:—"Rex," "Powerplus," and "Precision."

(*c*) The best results as regards facility in starting from cold are obtained under the following conditions:—

1. The throttle must be a good fit, but not quite air-tight.
2. The extra air supply, if any, must be completely shut.
3. The engine should be primed with a small quantity of alcohol.
4. It is advisable to draw the priming charge into the cylinder by slowly pulling the engine round; this method distributes the priming charge well over the inside of the cylinder.
5. On rotating the starting handle at a fair rate, the engine picks up on the third or fourth compression stroke.

The starting diagrams shown above were taken in the Kelly and Lewis engine referred to in paragraph (*a*). In the first diagram the engine was primed with 5cc. of alcohol. This quantity appears to have been evenly distributed and volatilized in the cylinder. In the second diagram a priming charge of 10cc. was used. It will be seen that the graduation from the highest pressure (282 lbs.) is uneven, indicating that there were apparently small quantities of alcohol in the cylinder not volatilized at the first compression stroke when explosion took place. In both cases the engine started at the fourth compression stroke.

In conclusion, it should be pointed out that the same results are obtained, as regards starting from cold, whether absolute alcohol or ordinary methylated spirit is used.

Wool Scouring Industry: Two Important Developments.

By W. RUSSELL GRIMWADE, B.Sc.

So great is the existence of natural grease in Australian wools that the Commonwealth could provide all the refined lanoline for local consumption, as well as the crude fats, and still have 90 per cent. of its production available for export. This result, however, is not obtained. Large quantities are lost in the scouring process. At Geelong, for instance, it is roughly estimated that 2 tons daily run to waste in the Barwon River. The refining of the fat is more a matter of systematizing and commercial economy than of chemistry. Hitherto the chief difficulty has been that the refiners have not been able to obtain a uniform raw material. Most scouring establishments treat all classes and ages of wools, and the crude fats, if recovered at all, are bulked together irrespective of grade and quality.

The fat derived from the fine wool of merino lambs, if kept separate, requires very little refining, and, as a rule, could be used almost without treatment as an ingredient of toilet lanoline. On the other hand, the fats from other wools are so crude that no amount of refining can make them suitable for toilet preparations, and the only useful purpose they can serve is as an ingredient of lubricants and axle greases. Decomposition and fermentation set in if they are kept for any length of time, and an evil smell is produced. It is essential, therefore, to the manufacture of good products that the fat should be treated as quickly as possible, since these defects cannot be eradicated by any but the most elaborate treatment.

Within the last few months, however, machines have been introduced into Australia from America which should facilitate the organization of the industry. The principle of the familiar cream separator has been adopted in their manufacture, and a super-centrifuge has been developed which is capable of continuously treating the enormous volume of scour liquors, and separating from them the small percentage of fat they contain. By this means a fairly uniform and suitable raw material, which may be treated by any one of several well-known processes, should be available to the refiner.

Toilet lanoline which is sold in tubes is by no means pure wool fat, and often contains only from 15 to 30 per cent. of pure lanoline. The pure fat is far too gelatinous and sticky to be acceptable as a toilet requisite. A less refined quality is a valuable aid to pharmacy as a basis for ointments, and as an improvement upon the greases hitherto used for that purpose. The crudest product, as previously stated, serves as a lubricant and as a thickening admixture to mineral lubricants.

In addition to the natural fats that wool contains, there is present also a fair proportion of alkali. The scouring is done with soda, which saponifies fats and de-greases the wool fibre. A recent discovery promises important developments in this industry. Under this new process, the potash contents of the wool are made to combine with the natural fatty acids, and so create a true soap in the form of an emulsion, which may itself be used as the detergent for a subsequent scouring operation.

A Forest Policy for Australia.

By C. E. LANE-POOLE.*

(I)

Of the many national assets that together we are wont to call our natural resources, there are few which hold so important a place in the economy of the nation as the forest. It differs from most other resources because, though under unsound management it certainly is exhaustible, it is nearly always replenishable, while, if it is utilized on sound sylvicultural principles, the forest becomes an inexhaustible asset. It is customary to look upon the mineral fields, be they gold or base metals or coal, the mother of industries, as the most valuable natural resources of the nation. Yet the mineral fields are all exhaustible, and a time will come when the last ounce of gold and the last ton of coal will have been won from the soil. In this the mineral fields differ essentially from the forest. The actual wealth of a mine may be regarded as a finite quantity, while the wealth of a forest is infinite. So long as the commercial profits of the undertaking are to a large extent utilized within the boundaries of the country, the work of winning the mineral from the ground is one which may well be left to the unrestricted activities of private enterprise. It is to the advantage of the nation to reap the whole golden harvest and utilize the wealth it yields to develop the commerce and industries which must follow in the wake of the mining industry. With the forest the position is entirely different. It happens all too frequently that forests are handed over to a private individual or to a company who treats it as one would do a mine, reaps all the crop, and leaves the area devastated and useless. Private commercial enterprise knows no other motive than private gain; it sees no further than the profits of to-day. If it looks forward at all, it is only as far as the time taken to write off its depreciating assets. The forests in such hands are naturally doomed; and so it is that no nation that has given the matter thought has allowed its forests to fall into the hands of the private individual or corporation.

From the earliest times the forests have been regarded as the property of the community in general, the reason being that the forest is an everlasting source of wealth, and is not the property of one generation alone, but of the nation for all time. The Romans were quick to realize this fundamental principle, and Justinian's Pandects lay down that the cutting of the coppice must be conducted by the timbermen as by the father of a family (*sicut pater familias caedebat*), and the large timber trees were to be reserved for the State's use.† The community could utilize the timber crop, but in such a manner that those who followed after them would find a supply sufficient for their needs also, and they again would leave sufficient, and so on down the ages, the forest would continue to yield its unfailing crop of timber. The early laws differ only in degree from those that are in force in the forests of Europe to-day. The basis of all methods of forest management is the same, viz., a restriction of the cutting so as to assure a continuity of supply.

In addition to the obvious value of timber, which has been felt from the beginning of time, the forests were found to have another value, which was almost as great, and this is their influence on the surrounding conditions of climate, water, and soil. Forests exert a beneficial influence by reducing the extremes of heat and cold, they increase the precipitation to a slight extent, while in mountainous country they act as great water storers, holding up the surplus of water which falls from the sky and letting it out slowly in the form of springs, so maintaining a contant flow in the rivers of the plains. The devastation wrought in the forests of the Alps and Vosges by graziers was followed by such appalling results that France learned a lesson never to be forgotten. Erosion of the hill sides, formation of torrents, destructive floods wiping out whole farms and villages were some of the results. The destruction of the forests of Algiers and certain other parts of Africa and Asia has been followed by the invasion of the desert sands, and vast areas of agricultural land have been rendered unproductive. Had Justinian's law been followed, and the cutting conducted as though by the father of a family, then they would only have cut what the forest would have replaced, and none

* Diplomé de l'École Nationale des Eaux et Forêts, Nancy; Conservator of Forests, Western Australia.
† Ulpian VII., *ad edict. provinciale.*

of the disasters would have followed. Instead, France is spending millions on her Reboisement des Montaignes, and in Algiers recourse is being had to the planting of Australian eucalypts to restore the forest conditions and stem the invasion of the desert.

With the knowledge of the true *rôle* of the forest there came the realization in many countries that the area of forest still remaining was inadequate for the needs of the community. The result was that the cutting laws were made more restrictive, and the tending of the woods became an urgent necessity. Colbert's

VICTORIAN FOREST, NAYOOK DISTRICT, WEST GIPPSLAND.

cry, "*La France perira faute de bois,*" led the way in that country towards the adoption of a sound forest policy, with the result that France did not perish through lack of wood, but her forests went far to enable both her own countrymen and the British to defeat the Germans. Sad inroads have been made into the forest wealth of France since 1914, and her forest working plans have been broken. Without those forests it would have been difficult, if not impossible, to keep the Allied Armies on the Western Front in the field. Colbert was followed by other foresters; and all the nations who were not actually on the threshold of their

development took steps to reserve what forests they possessed for the national good. The cult of forestry became slowly recognised, and the care of the forests became the charge of skilled men, whose duty it was to stand between the timber-man and the nation and apportion the timber crop in such a manner as to benefit the whole community for all time, and not only the present day converter of the wood. The forester laid down working plans for the management of the forests,

FELLING JARRAH, WESTERN AUSTRALIA.
Owing to Bush Fires and the Attacks of Boring Beetles it is often necessary to long butt these trees.

and these were based on sound sylvicultural principles, and extended over long periods. The plans restricted the amount of timber that could be felled annually, and the amount permissible was, of course, the *possibilité*, or the quantity that the whole forest would grow in a year. The position of the felling section

for each year was fixed; the operations necessary to assure the regeneration and proper growth of the best species on the cut-out areas were laid down. In this way a maximum of forest produce was assured; and yet only the forest interest was cut and utilized, the forest capital remained intact. In the utilization, waste

TIMBER COUNTRY AT NAYOOK, VICTORIA.

was, as far as possible, eliminated, which was a comparatively easy matter with a large timber-using population to cater for.

Yet, with all this care and forethought, a country like France soon found itself unable to supply its own needs in timber, and was forced to import large

PILES AT ADVENTURE BAY (TASMANIA) READY FOR TRANSPORT FOR ADMIRALTY HARBOR WORKS AT DOVER (ENGLAND).

quantities. Germany, too, who had perfected a particularly fine, if somewhat rigid, forest policy, and who possesses no less than 30,000,000 acres of forest, has also been obliged to rely on imported wood to make up the deficiency of her local

supplies. There arose the question then of how great an area in comparison to the total area of the country it is necessary to keep under forest for the supply of timber for the general needs of the community. This matter has been

BLUE GUM PILES IN TASMANIAN FOREST BEING FELLED FOR ADMIRALTY WORKS.

No. 1 STATE (WESTERN AUSTRALIA) SAW-MILL NEAR MANJINUP.
Output 30,000 super feet per day.

thoroughly investigated, and it has been laid down that an area of forest equal to one-quarter of the total extent is the bare minimum necessary in a well-developed country. There are not many countries that possess this proportion of

forest to-day, forest policies in most instances having come too late to save the necessary area. The result has been that most of the older countries have become large importers of timber, and are dependent on two sources of supply. Countries like Russia and Scandinavia, that have an excess of forest, and countries which have not reached their full development, and where forests, in consequence, are large in proportion to their population, such as Canada and other British Dominions, also countries along the West African coast.

In those British Dominions, where forests occurred in large areas they were naturally regarded by the early pioneer as obstacles to settlement, and were in most instances greatly destroyed before a market for the timber was found. When an outlet was discovered, and saw-mills and the lumbering business generally came to be established, the young nation, that had always regarded the forests as its natural enemy, very naturally welcomed this means of clearing the land. The mills were to be the forerunner of settlement, and every encouragement was given to the lumber company to take up large areas of forest and develop an export trade. Concessions were granted on terms which we to-day can only regard as most generous; leases were taken by the saw-miller on a practically peppercorn rental, and he was regarded almost in the light of a philanthropist. Even to-day the larger milling companies still take up the attitude that they have been, and are, the saviours of the State, and have done it an incalculable benefit through the clearing of land, the circulation of money in wages, and the purchase of produce. In reality, such concerns have destroyed a large proportion of the national wealth by forcing an export market for the timber before the local demand had grown sufficiently to absorb the smaller sizes and other timber not ordered from overseas. Such timber, through lack of any local market, and the impossibility of stacking and storing it, has been burnt. The saw-millers of the Dominions were not slow to seize on their opportunities, and soon it was not a case of cutting timber on agricultural land to assist land settlement, but cutting timber anywhere and everywhere. Their road was made easy for them, for the pioneer population continued to encourage them, until finally they became so well established, and wielded so strong an influence with local Governments, as to make their position unassailable.

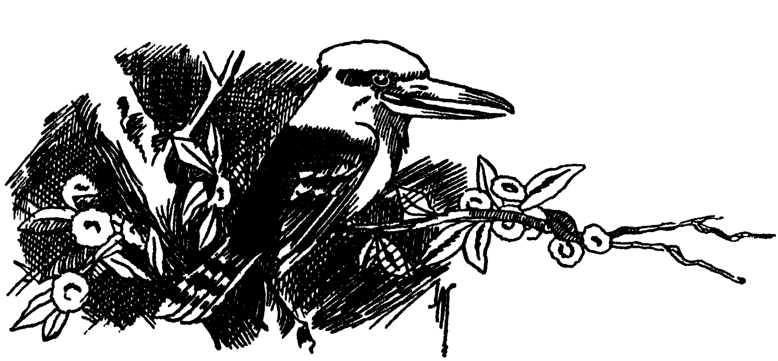
The forests were treated as mines, whose wealth is exhaustible and not replenishable, and the science of forestry was lost sight of in the endeavour to saw up all the crop in sight. It was often argued, and is to-day in New Zealand, that the local timbers grow too slowly, and are not worth any form of conservative cutting, but recourse must be had to exotics. Instead of ascertaining the actual growth per acre per annum of the forest, and allowing that quantity of timber, and that only, to be cut, the whole forest was attacked, and the crop reaped as quickly as possible. The unfortunate part is that the saw-miller, in his inroads on the virgin forest, only takes the best of the crop; he chooses all the fine-grade mill logs, all the straightest piles for harbor work, and cleanest poles for telegraph and other purposes. He leaves the forest in a deplorable state; the percentage of over-mature and dying trees, which in a virgin forest is always great, is naturally increased; while the best of the timber, which should have made the future forests, goes in piles and poles. The fires following the logging operations are a further menace, and it is often the case that whole forest regions have been destroyed through this cause. Thus, while we see the older countries embarking on a policy of careful utilization, under which the forests yield a perpetual crop of timber, the young countries, profiting by the older ones' need for lumber supplies, embarked on a system of reckless exploitation.

The unassailable position of the saw-millers in these new countries continues only so long as the timber supply lasts. As soon as there is evidence of the end of it being in sight, then the anxiety of the community is aroused, and steps are taken to remedy matters. Countries suddenly wake up to the fact that the resource which they had looked upon as inexhaustible was practically exhausted, and that areas of purely forest country, unfit for any form of agriculture, had been laid waste and rendered sterile. When this stage is reached, the community frenziedly attempts to remedy matters. It demands of its Government a forest policy, and it, as a rule, gets some sort of legislation entitled a Forest Act. A perusal of the history of any of the timber States of the American Union will show in its successive stages the evolution of forestry. First, destruction of forest for farming purposes; next, destruction of the forest by the saw-miller; finally, exhaustion of the forest and the birth of

forestry. The forest policy, that is the natural sequence of the community's desire to make up for past misdeeds and restore once more the forest heritage is naturally very expensive to carry out. The forests may have been so cut out that planting has to be resorted to, forest land may have to be purchased from the owners who were granted it in the bad old days, and always the sylvicultural operations to be carried out are expensive. Had only the forest policy been inaugurated early in the saw-milling days, then the forest regeneration work would have gone hand in hand with the logging operations; the saw-miller would bear the cost; the royalty, lease rent or stumpage due, whatever it may have been called, would have amply paid for such work, and would have left a handsome enough profit for the Treasury. The industry could at that time have been made permanent, and all the horrors of the deserted mill townships would have been avoided. Instead, the country only wakes up to the fact too late, and the community must of necessity dive deep into its pocket if it is to make good the wastage of the past. In many cases the reforestation is so expensive a scheme as to give the Government pause, and often it is abandoned, or some sop is thrown to the people in the way of a nursery for raising trees for free distribution, or a law is added to the statute-book absolving farmers who plant trees from taxation on the portion of the land they have planted.

Australia's forest history has been on the same lines as other English-speaking countries. She differs from Canada only in the degree of the destruction she has wrought and in the fact that her forest heritage is the smallest of any country of her size. In certain parts she has reached such a stage of destruction that she has been forced to adopt a forest policy, in others she still continues recklessly to destroy. Where the timber area was least of all originally, viz., in South Australia, forestry has been longest established. Victoria, with its rapidly-growing population and exhausted forests, came next, then New South Wales. Queensland alone would seem to have adopted a policy before the exhaustion of her forests—she has only a skeleton Act to help the forest authority; but, in spite of this, she has broken away from the groove of the other States by establishing the sale by auction of her timber in short saw-milling permits, and by abolishing the licence system. Western Australia groans under the burden of 700,000 acres of timber concessions and leases, and an export trade which means the prostitution of some of the finest hardwoods to such a degraded use as sleepers, and the annual destruction of over 500,000 tons of sound timber at the saw-mill fire chutes. Her forests are not yet exhausted, and she has an Act which, with the natural termination of the leases and concessions in the near future, will enable her to put her forest house in order. Tasmania is still frankly destroying her forests; and this is again only natural, as she is the one State of all the Commonwealth group which is *primâ facie* a forest country, and her proportion of forest to other land is greatest of all.

(To be concluded.)



Bureau of Information.

SERVES A USEFUL PURPOSE.

In the original report of the Conference convened by the Prime Minister in January, 1916, when the scheme for establishing a Commonwealth Institute of Science and Industry was first definitely launched, a recommendation was made that until the permanent Institute is established an Advisory Council should be appointed particularly to carry out two specific objects, one of which is as follows:—

"The collection of industrial scientific information, and the foundation of a bureau for its dissemination amongst those engaged in industry."

As a first step in the direction of creating the Bureau of Information, a Science Abstractor was appointed in July, 1916, who, though primarily engaged in preparing reports and abstracts for the immediate use of the executive committee, devoted his remaining time to compiling a card index of information likely to be useful in the work of the Bureau. With the very limited staff available, the progress made in this work was necessarily somewhat slow. Moreover, until the Institute recently moved into its new offices, no proper provision could be made for shelving accommodation for the books and reports which had been collected and indexed. Suitable accommodation has, however, now been provided, and a Librarian and Cataloguer have been appointed, the former as a joint officer of the Institute of Science and Industry and the Bureau of Commerce and Industry. The nucleus of a scientific and technical library has now been established, some 2,500 books having been indexed and catalogued, in addition to hundreds of pamphlets and bulletins.

Towards the end of March last an announcement was made by the Minister for Trade and Customs (the Hon. W. Massy Greene) to the effect that the necessary preliminary work in establishing the Bureau of Information on a small scale had been completed, and that the Institute was prepared to receive from manufacturers and persons engaged in primary industries requests for information and advice on scientific and technical questions. Since that date a large number of requests for information on a wide variety of subjects has been received and answered. Among them the following may be specially mentioned:—

Subject.	Information or Advice Desired.
SPEAR GRASS TREE (*Xanthorrhœa hastilis*)	Specimen sent for identification and information as to utilization for fibre or paper-pulping purposes
DOLOMITE	Methods of preparing and using ground burnt dolomite for lining cupola furnaces
WOOLLEN MILLS	Machinery required for woollen mills, with estimates of cost
IRON MOULDERS' SAND.. ..	Possibility of obtaining suitable sand from deposits in the vicinity of Shepparton, Victoria
SALT	Technology of processes for manufacture
ARTESIAN WATER SUPPLY ..	Bibliography

REQUESTS FOR INFORMATION—*continued.*

Subject.	Information or Advice Desired.
VACCA GUM	Information regarding production exports, utilization, and where supplies obtainable
TUBES	Processes for manufacture of small iron tubes for water, gas and low-pressure steam
FELSPATHOID ROCKS	Occurrence in Australia and methods of treatment for extraction of potash salts
PEANUTS (*Arachis hypogæa*) ..	Suitability for cultivation in Australia and methods of cultivation
SHEEP DIPS	Analyses and processes for manufacture of various classes of dips
OCHRES AND KAOLIN	Advice as to purpose for which they can be utilized, value, &c.
BARIUM CARBONATE .. .	Information as to whether obtainable in Australia
MANGROVE BARK	Decolourisation methods
MANGROVE BARK . ..	Utilization of spent bark for corroding work in paint manufacture
DRIED FRUITS	Analyses and nutritive values
ALUNITE	Analysis of ore and advice as to suitability as source of potash
ELECTRICAL METHOD OF PROSPECTING FOR ORES	General information
RABBIT SKINS	Suitability as raw material for manufacture of fine gelatine
SULPHUR	Fertilizing effect
QUEENSLAND RUBBER VINE .. (*Cryptostegia grandiflora*)	Advice as to possibility of utilization as source of rubber
GINGER .. .. (*Officinale ammomum zingiber*)	Suitability for cultivation in Australia, information *re* preservation, &c.
LEATHER CLEANING MATERIAL	Analyses and methods of manufacture of liquid suede-leather cleaners
FIREBRICKS	Tests as to suitability for various temperatures and purposes
COPRA	Methods of drying and curing and of extracting oil
DIRECT UTILIZATION OF SUN'S HEAT	Methods adopted in Egypt and other countries
ALMONDS, COCOANUTS, AND COCOA BEANS	Prospects of large scale cultivation in Australia
PENCILS AND INKS	Analyses and methods of manufacture of copying ink and filling for indelible pencils
MAGNESITE	Analyses, purposes for which supplies, demand, used, and price
CARBURATION OF ALCOHOL ..	Bibliography and general information

It will be seen that a large proportion of the inquiries are in connexion with the establishment of new industries in the Commonwealth. In conclusion, it may be mentioned that in a number of cases replies have been received from the persons to whom information has been sent expressing high appreciation of the nature of the particulars furnished and of the promptness with which they were supplied. There are already indications that in more than one case the information furnished by the Bureau is likely to be of material assistance in the establishment of new industries

Imperial Mineral Resources Bureau: Action Taken in Australia.

In April, 1916, the Imperial War Conference passed a resolution emphasizing the importance of establishing at London an Imperial Mineral Resources Bureau, the main objects of which would be—

(*a*) to collect and disseminate information regarding the mineral resources, methods and treatment, consumption and requirements of the Empire of every mineral and metal of economic value; and

(*b*) to advise regarding action to be taken for the development of resources.

An Imperial Mineral Resources Bureau Committee was established by the Minister for Munitions to draft a constitution and a scheme for establishing the Bureau. A copy of the report of this Committee was sent in October, 1917, to the Commonwealth Government. It was first transmitted by the Prime Minister's Department to Sir John Higgins, who strongly supported the proposals to establish a Bureau, and recommended affiliation between the Bureau and the Commonwealth Institute of Science and Industry. The papers were then sent on by the Prime Minister's Department for the consideration of the Executive. In the meantime, Mr. W. S. Robinson had been appointed to represent the Commonwealth on the Bureau.

In April, 1918, a recommendation was sent by the Executive Committee to the Prime Minister's Department, stating as follows:—

(*a*) The Executive considered that the Institute of Science and Industry should actively support and assist the Imperial Mineral Resources Bureau.

(*b*) With that object in view, the Executive contemplated the appointment of a fully qualified mining engineer, with metallurgical experience, to collect and co-ordinate all information available regarding the mineral resources, metal requirements, and metallurgical processes of the Commonwealth.

(*c*) The Executive stated that, before taking any active steps in the matter, it would be desirable to ascertain whether the Imperial Mineral Resources Bureau had any suggestion to make with a view to increasing the value of the data by collection and compiling it on some uniform plan.

(*d*) The Executive recommended that it should be in direct communication with the Commonwealth representative on the Bureau (Mr. W. S. Robinson).

Since that recommendation was made, the matter has been discussed by the Prime Minister with the Imperial authorities in London. The scheme for the establishment of the Bureau was unanimously approved by the Imperial Conference, and the Bureau has now been established by charter.

Recently a cablegram has been received stating that the Imperial Mineral Resources Bureau requires, as early as possible, a report showing Australian resources, with detailed information relating to location,

quantity, composition, output, methods of treatment, &c., as well as annual comparative statistics showing production, consumption, exports and their destination, imports and their sources and prices. It was requested that the following classification should be rigidly adhered to:—

(*a*) Carbonaceous, including mineral oils.
(*b*) Iron and manganese.
(*c*) Non-ferrous.
(*d*) Refractories.
(*e*) Fertilizers, &c.
(*f*) Precious stones.

The information required by the Bureau is being collected by the Australian Metals Exchange through the State Departments of Mines. Any steps which may be found necessary to supplement the scientific and technological information available *re* metallurgical processes and methods of treatment will be taken by the Institute of Science and Industry.

ORGANIZATION AND POWERS OF BUREAU.

The Imperial Mineral Resources Bureau, as established under charter, will be controlled by a governing body consisting of representatives of the various parts of the Empire and of other persons appointed by the Minister of Reconstruction, the representative for the United Kingdom being salaried Chairman. The main purposes of the Bureau are as follows:—

(i) To collect and disseminate information as to the resources, production, treatment, &c., of every mineral and metal of economic value.
(ii) To ascertain the scope of existing agencies, with a view to avoiding any unnecessary overlapping.
(iii) To assist and supplement existing agencies.
(iv) To advise on the development of the mineral resources of the Empire.

The Bureau is authorized to acquire land to the extent of 5 acres in any part of the Empire, and such buildings and personal property as may be required; to appoint officers to carry out the work; and to enter into such arrangements with any Department of the Government of the United Kingdom or of the Government of any part of our Empire or of any foreign State as may be desirable with a view to the exercise of any of the powers of the Bureau. The Governors may appoint advisory Committees to advise on any special subject. Four standing Committees are to be appointed to deal with—

1. *Intelligence and Publications.*—This Committee is to concentrate on the collection of statistical and other information, and to answer all inquiries. Its work will fall under four heads, viz.:—

(*a*) *Resources*—by which is meant the collection of information relating to location, transport, quantity, composition, treatment, &c.
(*b*) *Annual and other Periodical Statistics*—dealing with production, consumption, exports and imports, prices, &c.
(*c*) *Abstracts* of technical and trade papers, &c.
(*d*) *Library and Card Index* of technical literature, &c.

It will also be the duty of this Committee to prepare the annual reports of the Bureau.

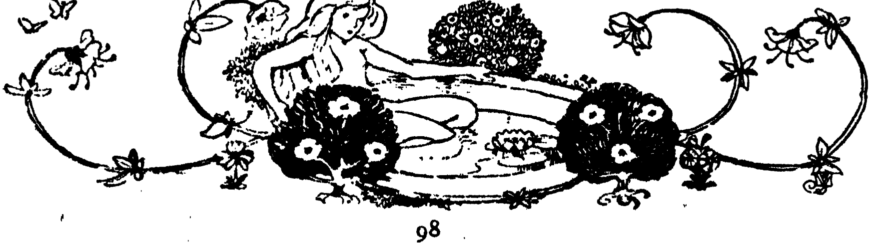
2. *Research and Development.*—In this instance, the main objects will be the improving of current processes as well as the introduction of new ones. On application, an expert or group of experts would be sent to any part of the Empire to carry out any particular research in co-operation with existing agencies there.

3. *Legal.*—This Committee will collect complete information relative to the mining laws and practice of all parts of the Empire and other countries.

4. *General Purposes and Finance.*—This Committee will deal almost entirely with such questions as staff, office premises, and financial relations with other institutions, such as what charge (if any) should be made for information supplied.

The Bureau is in the first instance to be financed by the Imperial Parliament, but may receive any funds granted by the Legislature of any other part of the Empire.

> **Occasionally, and frequently, the exercise of the judgment ought to end in absolute reservation. We are not infallible, and so we ought to be cautious.**
>
> —*FARADAY.*



Castor Oil Plant: A Possible New Industry.

By W. B. ALEXANDER, M.A.*

1. *Introduction.*—Castor oil is derived from the seed of the castor plant, *Ricinus communis, L.*, which is believed to be a native of North Africa and India. Of this plant there are numerous varieties, which are sometimes regarded as distinct species.

The castor plant is cultivated as a crop in India, Java, Brazil, and the United States, and is grown as an ornamental garden shrub in most of the warmer countries of the world. It is also found as a wild or semi-wild plant in most warm countries, having probably escaped from cultivation.

In the tropics it forms a small tree from 20 to 30 feet or more in height. In warm-temperate climates it is a shrub 8 to 12 feet high, whilst in localities where frost occurs it is a herbaceous perennial. Under cultivation in temperate climates it is treated as an annual.

In India the leaves are used as fodder for cattle, and in Assam they are used for feeding the Eri silkworm. The chief product of the plant is, however, the seed or castor-bean from which oil is extracted.

The beans produced by different varieties vary in size, colour, and shape, as well as in oil content. For practical purposes the varieties may be grouped as large- and small-seeded forms. The former are more prolific in yield, and the oil obtained from them is used chiefly for lubricating and industrial purposes; the small-seeded varieties yield the better quality oil used in medicine.

2. *Cultivation.*—Since the castor plant is sensitive to frost it requires a warm climate or a temperate climate with a long summer. In general it will succeed in any locality where maize will ripen. Moisture is essential for the germination of the seed, but when once the plant is established it requires little rain, and excessive rainfall is injurious to it. The most suitable soils are rich, well-drained sandy or clayey loams, or in general soils which will produce good wheat or maize crops. Very loose sand and heavy clays are alike unsuitable.

Deep ploughing and harrowing are essential. The plant is exhausting to the soil, and, except in virgin land, requires manuring. For this purpose the residual cake left after expressing the oil is valuable, and the leaves and seed-husks of the plants are also useful if ploughed in. Pure crops should not be taken from the same land more than once in five or six years. In India it is not often grown as a pure crop, but is usually grown as a hedge round cotton or sugar fields.

3. *Harvesting.*—The capsules of the small-seeded varieties begin to ripen in four to five months; those of the large-seeded varieties in seven to ten months after sowing. Since when ripe the capsules of many varieties burst suddenly and scatter the seed to a considerable distance, it is necessary to gather the spikes bearing the capsules as soon as they show signs of ripening. When ripening has commenced the crop requires looking over once a week, in order that ripening capsules may be gathered. An attempt has been made in the United States to produce a variety which ripens all its capsules at once, but, apparently, this has not been accomplished.

The capsules when gathered are spread out on a floor, preferably in an open shed, where they are exposed to the sun and protected from the rain. They need to be turned over from time to time. When all the capsules have shed their seed

* Secretary to the Special Committee on the Castor Oil Plant.

the husks are removed and the seeds swept up and collected. Capsules are also gathered from wild plants, and the seed obtained in the same manner.

India is the principal producing country, exporting annually about 1,800,000 cwts. of beans. In addition, about 1,500,000 gallons of oil are exported annually from seed crushed in India. Before the war about 400,000 gallons of this oil were exported to Australia.

4. *Extraction of the Oil.*—Castor beans are crushed by crude native machinery in India as well as by more modern machinery. Beans imported to Europe are crushed chiefly at Hull and Marseilles by methods similar to those adopted for other oil seeds. The only firm in Australia which manufactures the oil from imported seed is Lycett Proprietary Ltd., Normanby-road, Montague, Melbourne.

For the finer grades of oil, selected seed is taken, the husk removed, and the soft kernels expressed in the cold. The colourless oil thus obtained is free from the poisonous principle—ricin—which is present in the seeds. The remaining cake is pressed again, yielding inferior oil.

Inferior seed is hot-pressed directly, or else the oil is extracted by solvents. The solvents used are carbon bisulphide or alcohol. The oil is subsequently refined by steaming.

The beans contain 46 to 53 per cent. of oil, about 40 per cent. being obtained by expression. The residual cake is not available for stock feeding, since it contains the poisonous ricin. It is, however, as already mentioned, a useful manure.

5. *The Castor Plant in Australia.*—The castor plant grows wild in many parts of Australia, particularly in Western Australia, along the Torrens River in South Australia, and in the neighbourhood of Sydney. Mr. W. M. Doherty, F.I.C., stated in a communication to the Industrial Section of the Royal Society of New South Wales, in April, 1918, that he had collected seeds from a vigorous plant growing in sand near the shore of Botany Bay, and he exhibited samples of oil crushed from the seed of two varieties grown at Wamberal, near Gosford, New South Wales. The analysis of the oil was quite satisfactory.

Lycett Pty. Ltd. have tested two samples of seed from Western Australia on a laboratory scale, and obtained 47 and 49 per cent. of oil respectively, as against 53 per cent. from Calcutta and Java beans. This is high enough to form a paying proposition, provided the seed could be obtained in sufficient quantities.

6. *Prospects of the Industry.*—Castor oil is used largely as a lubricant for machinery, especially in warm climates, and its use has been increased lately in Europe and the United States owing to the demand for it as a lubricant for aeroplane engines. The present price of the seed in Australia is £20 to £25 per ton c.i.f. Melbourne, and the demand is about 200 tons per month. Before the war the price was £11 to £13 per ton, but it is improbable that prices will ever again fall as low as this.

The crop, as already indicated, is a quick-growing one, and seed can be harvested within six to ten months. The chief drawback is undoubtedly the labour required in gathering the seed. In addition, there is no experience available in Australia as to the best cultural methods, nor as to the best varieties of seed for cultivation. Lycett Pty. Ltd. are prepared to supply Indian seed to intending cultivators.

CASTOR OIL PLANT: A POSSIBLE NEW INDUSTRY.

The Special Committee investigating this subject consists of—

Mr. H. PYE, Cerealist to the Victorian Government, Agricultural College, Dookie (Chairman);

Mr. E. C. LYCETT, Lycett Pty. Ltd., Castor Oil Manufacturers, Montague, Melbourne;

Mr. C. NAPIER, Cockatoo;

Mr. W. B. ALEXANDER (Secretary);

with Mr. D. JONES (Brisbane), and Mr. W. J. SPAFFORD (Adelaide), as corresponding members.

Extracts from the two progress reports of the Committee follow:—

EXTRACTS FROM FIRST PROGRESS REPORT, NOVEMBER, 1918.

1. *Experiments at Cockatoo.*—Mr. Napier's land has been ploughed, and the greater portion of it sown with castor seeds. Certain areas have, however, been left for transplanting seedlings which will be thinned out.

Four varieties of seed are being grown on a large scale, viz., Coconada (India), Java, New Caledonia, and Bengal. A small area has been planted with seed from Dookie, Victoria, and seeds of thirteen other varieties are being grown in an experimental bed.

Seedlings of some of the varieties are now appearing, and a small amount of damage has been done by slugs. Specimens of these, and of certain insects observed on the crop, are being preserved, together with specimens showing damage done by the slugs.

2. *Experiments at Violet Town.*—Mr. Lycett is experimenting with seven different varieties. About 39 acres have been planted with Coconada seed, 1 acre has been divided between Java and New Caledonia seed, and short rows of four other varieties have been planted.

3. *Information from Queensland.*—Mr. D. Jones has supplied a considerable amount of information as to conditions in Queensland, from which it appears that a number of very distinct varieties are growing in that State, and that the castor oil plant does especially well in the north and west. Mr. Jones has interested himself in the cultivation of this plant for a number of years, and has been growing a variety called by him "Eureka," which he has distributed to a number of persons from time to time. Mr. J. B. Henderson, Government Analyst, Brisbane, reported that a sample of seed of this variety submitted to him contained 59 per cent. of oil, but a sample submitted to Mr. Lycett was not found so satisfactory. Mr. Jones was responsible for the introduction of seed into New Caledonia about six years ago, but during the intervening period the seed appears to have become somewhat modified, and the oil content of New Caledonian seed tested by Mr. Lycett was considerably higher than that of the Eureka seed supplied by Mr. Jones.

EXTRACTS FROM SECOND PROGRESS REPORT, FEBRUARY, 1919.

1. *Experiments at Cockatoo.*—The seeds sown at Cockatoo were very slow in germinating, probably owing to the late cold spring, and some of the earlier plants were checked by late frosts, though they were not actually killed. The very dry summer has been inimical to the growth of the plants, and of the 40 acres sown only about 15 acres appear likely to bear this year, though it is probable that some of the other plants might come into bearing if good rains were received. The plants which have done well are the ones on the flats, where the soil has remained moist. Many of these plants are from 3 to 4 feet high, and are flowering and fruiting freely.

Of the varieties sown that from Java has done much the best, whilst the Bengal and Coconada varieties are also growing fairly well. The New Caledonia beans were slow in germinating, and though the plants are strong and healthy they have not yet begun flowering. Of the numerous varieties planted in the experimental plot, only that from seed collected by Mr. Napier, at Dookie, Victoria, has grown, and this variety is not yet in flower.

The plants look remarkably healthy. The lower leaves on some of them have been eaten to a small extent, possibly by grasshoppers, and on three adjacent plants a considerable number of caterpillars of the Painted Apple Moth (*Teia anartoides*) were found, all of the same age and evidently the progeny of a single moth.

A small corner of one of the flats was accidentally flooded by the blocking of a drain, with the result that many of the plants in the flooded area were killed and the remainder badly checked. This result is attributed by Mr. Napier to the coldness of the water.

2. *Experiments at Violet Town.*—Though a number of the plants grew for a time, the prolonged dry weather has, unfortunately, killed most of them.

3. *Work in Queensland.*—Mr. Jones has forwarded four samples of beans collected by him, which are being tested for oil-content and acidity. He reports considerable interest in the crop amongst Queensland farmers, and considers that the State should produce a large quantity of beans in a few years' time.

4. *Collection and Supply of Information.*—In response to a request for information as to the position in the United States, Mr. W. W. Stockberger, Physiologist in charge of Drug, Poisonous and Oil Plant Investigations, in the Bureau of Plant Industry, has supplied copies of the latest statement of the Bureau as to the cultivation of castor beans. He states that there are no special machines used for sowing or gathering the castor beans, but that several firms have produced castor bean threshing machines. He has asked the two firms manufacturing the best of these to supply particulars to the Committee, but these have not yet been received.

An article appeared in the *Agricultural Gazette* of New South Wales for December, 1918, by Mr. H. Ross, from which it was evident that the writer was not fully informed of the present position in Australia, the statistics of consumption given being out of date, and the writer stating that there was no market for the crop in Australia. The latest statistics and information as to market and prices were sent by the Committee in a letter to the editor.

Information has also been supplied to Mr. G. L. Sutton, Commissioner for the Wheat Belt, Western Australia, in response to his request, in view of inquiries made by prospective growers in that State. Copies of valuable articles appearing in the *Tropical Agriculturist* and the *Queensland Agricultural Journal* have been circulated amongst members of the Committee.

5. *Additional Corresponding Member of the Committee.*—Mr. W. J. Spafford, Experimentalist, Department of Agriculture, South Australia, has been appointed a corresponding member of the Committee.

6. *Prizes at Agricultural Show.*—The Royal Agricultural Society of Victoria has agreed, at the request of Mr. Pye, to offer a prize for castor beans at the Show. A similar request is being made to the New South Wales Society, and it is proposed also to approach the societies in other States.

7. *Importation of Seed.*—The Indian Government has prohibited the export of castor beans in order to stimulate the local manufacture of castor oil. This will

probably result in a serious curtailment of the supplies available for the manufacture of castor oil in Australia, and emphasizes the importance of growing sufficient beans locally to supply Australian requirements.

From figures supplied by Mr. Lycett, and those of the Commonwealth Statistician, it appears that the quantities of castor beans used in Australia in recent years are as follows:—

Year.	Tons.	Bushels of 46 lbs.
1914-15	3,700	180,400
1915-16	2,700	133,500
1916-17	2,900	140,400

These figures have been arrived at by adding to the quantities of beans actually imported the quantities which would have been required to produce the imported castor oil. More than half the oil used in Australia in recent years has been manufactured locally from imported seed.

It aint the guns nor armament, nor the funds that they can pay,
But the close co-operation that makes them win the day.
It aint the individual nor the army as a whole,
But the everlastin' team work of every bloomin' soul.

-RUDYARD KIPLING.

Scientific Road Making.

NEED OF LOCAL RESEARCH.

By GERALD LIGHTFOOT, M.A.

Although no revenue is now derived directly from roads in Australia, they are, of course, of the greatest value and importance to the community, and, next to railways and public lands, they form the most valuable item of national property. Statistics are not available to show the total expenditure by State Governments and local authorities on roads, but the expenditure by the New South Wales Roads Department and Road Trusts alone, from 1857 to 1917 inclusive, was nearly £25,300,000. The expenditure on roads by State Governments from loan moneys in the year 1915-16 was £782,000.

It has been stated publicly by a high authority in Australia that no expenditure of public funds has involved greater waste of money than that on roads. In several of the States the methods of construction and maintenance of roads usually vary according to individual ideas of practice, sometimes sound—too often not. There is frequently no scientific control and no standardization of method. There is often an absence of knowledge of contemporary or past history of the developments of road engineering in older countries of the world, while very little research or experimental work is conducted on local road-making materials. Moreover, there is no adequate provision for the collation and dissemination of information or data of practical value to the road-builder.

During a visit to the United States and England, in 1916, I had the opportunity of acquiring information regarding the work and organization of various institutions concerned in the scientific control of road development, construction, and maintenance. This information I placed before the Executive Committee of the Institute of Science and Industry, which, after carefully considering the matter, concluded that, whilst valuable work is being carried out at State Departmental and University laboratories in Australia in connexion with the testing of road materials and cognate matters, there is urgent need for instituting systematic research work in connexion with road making. The Institute accordingly appointed a Special Committee to report on the whole matter, and, if thought desirable, to formulate the outline of a scheme for the establishment of a Commonwealth Roads Research Laboratory.

In the two following sections of this article some brief information is given regarding the scientific control of road construction and maintenance in the United States and England respectively. In the last section, the outline of a scheme is given for the establishment of a Commonwealth Roads Research Laboratory.

The Office of Public Roads, Department of Agriculture, United States of America.

The Federal Government of the United States of America long ago realized its responsibility in connexion with public roads, and for the

purpose of systematizing and correlating the efforts of the individual States in the financing and scientific control of highway projects, established the Office of Public Roads. The work of that Office has admirably fulfilled its objects, with the result that the Federal Government has recently passed a Bill appropriating a sum of £15,000,000, to be expended in five years, subsidizing £1 for £1 State expenditure on approved main roads. Grants from the fund are contingent upon the States establishing properly constituted Highway Commissions, which are responsible to the Federal Office of Public Roads for carrying into effect the specifications provided. As a consequence, many of the States have organized Highway Commissions in order to avail themselves of Federal aid. A national asset in the form of a highly developed network of properly constructed roads is thus in process of development.

The Office of Public Roads takes the lead in investigational and experimental work, with the object of securing data which is necessary before the most economical methods of road building and maintenance under widely varying conditions can be determined. It acts as a central agency for investigational work, and furnishes authoritative information on all matters pertaining to roads. It has laboratories for testing and research work; it issues numerous publications of an educational character, and it includes amongst its employees a number of highly qualified experts in road engineering. It actively aids the States and local government bodies with advice or suggestions, and makes demonstrations of the methods it advocates.

The work of the Office of Public Roads is divided into four main divisions, viz., (*a*) Road management investigations; (*b*) Road building and maintenance investigations; (*c*) Road material tests and research; and (*d*) Field experiments. For each of the first three divisions there is a separate scientific staff. The work in the last division is carried out in collaboration between the various members of the staff of road engineers, chemists, physicists, and mechanical engineers.

(*a*) *Road Management Investigations.*—In the road management investigations economic studies are made of roads and road systems. This involves investigations into the character and amount of traffic, cost of hauling, financial outlay, benefits to the community, and saving to the Government in the cost of postal delivery. In addition, all available information and statistics relating to roads are collected and systematized with a view to finding out the types of road, nature of materials, and methods of maintenance which are yielding the best results at the least cost, and to ascertain the best kind of road to construct to meet particular traffic conditions.

(*b*) *Road Building and Maintenance Investigations.*—In the road building and maintenance investigations research is carried out to determine the cheapest and most efficient methods of construction and maintenance, and the information thus acquired is disseminated to road officials throughout the country. Object-lesson roads are constructed to demonstrate proper methods of building. When an application is received from a road authority for advice or assistance, an engineer is detailed from the Office of Public Roads to superintend the construction of a short section of road, and he remains on the job

until he has thoroughly instructed the local officer. Experts are also sent out, on request, to study the whole system of roads in a local district, and to formulate a plan of action for their improvement. Standard plans and specifications for bridges and other structures are prepared in the office and furnished to local authorities.

(*c*) *Road Materials, Test, and Research.*—This branch carries out investigations of road-building rocks, dust preventives, and road binders. Routine tests are carried out free of charge when submitted by State and local government officials, or by good-roads organizations.

(*d*) *Field Experiments.*—Experiments are carried out to determine the relative merits of various materials, and of the various methods and types of road construction and maintenance. A section of road is selected, and co-operative arrangements are entered into with local authorities. The Office of Public Roads retains the right to carry out the experiments. Short sections of road are constructed, extending over the entire length selected, each section being an experiment in itself, designed to determine the relative merits of certain road materials and the best methods of using them. Systematic inspections are made periodically. Field experiments are also carried out to determine the effect of width of tire, diameter of wheel, type and size of axle bearing, and power required to haul vehicles of different types over various classes of road surfaces.

Research Work at the National Physical Laboratory, England.

A special laboratory for testing road materials and methods of construction has been established at the National Physical Laboratory under the auspices of the Road Board. There is a complete installation for testing road materials, such as stone, for resistance to impact, abrasion, &c.; but the most important part of the installation is the "road-testing machine." This is an arrangement whereby an actual experimental road can be tested to destruction under what may be described as intensified traffic conditions. The road to be tested is laid down in the form of a circular track, 2 feet wide and 30 feet in diameter—the foundation of the road is provided in the shape of a concrete channel, in which the bituminous or other road material can be laid under excellent conditions. On the experimental road or track thus constructed eight heavy steel-shod wheels are run, generally at a speed of 8 miles per hour, and each wheel is separately loaded and driven, so that the wheel does not merely run on the road, but transmits to it driving stresses such as occur in practice. The conditions are, in fact, very similar to those which exist on a modern road under heavy traffic, but the wear of the road is accelerated owing to the fact that the artificial traffic is much more concentrated and continuous than it would be in actual practice. It has been found experimentally that few roads can resist the wear of this testing machine for more than a few days, particularly when the surface is kept wetted. Information as to the relative wearing properties of roads constructed with different materials or on different methods can thus be obtained much more rapidly, and under much more definite conditions, and at smaller cost, than by experiments on actual roads.

SCIENTIFIC ROAD MAKING.

PROPOSALS FOR A COMMONWEALTH ROADS LABORATORY.

The Special Committee established by the Institute to consider the proposal that the Commonwealth should initiate experimental research on road making consisted of Mr. W. Calder, M.I.C.E. (Country Roads Board of Victoria); Mr. J. M. Coane (Consulting Roads Engineer, Melbourne); Professor H. Payne (Engineering Department, Melbourne University); and the writer of this article. The Committee strongly supports the proposal, and, with a view to giving effect thereto, has made the following recommendations to the Institute:—

(1) That there should be a central Commonwealth organization to collaborate with State and local bodies in the matters of forwarding the construction of good roads throughout the Commonwealth, of testing and advising on road-making methods, materials, and machinery, and of improving the facilities for the training of road engineers.

(2) That such an organization should be linked up as a branch of the Commonwealth Institute of Science and Industry, and should consist of—

(*a*) A small Committee of experts to supervise and direct the work generally.

(*b*) A qualified engineer experienced in road design and construction and experimental physics.

(*c*) A laboratory (as specified in the following paragraph) and such assistance as may be necessary.

(3) That, in connexion with the Commonwealth organization, a central experimental laboratory should be established for research into the properties of road-making materials, and for work in connexion with the determination of standards for use in the Commonwealth.

(4) That steps should be taken to secure co-operation between the Commonwealth organization and the existing State and University laboratories, which will, as a matter of course, continue to carry out and develop their present work.

(5) That the Department of Defence should work in collaboration with the Commonwealth road organization, so that military requirements may be efficiently met.

(6) That every effort should be made to co-ordinate road construction with any possible future requirements of aerial traffic.

(7) That the main functions of the Commonwealth road organization should be as follows:—

(*a*) The collation of literature relating to past and present experimental work on road construction and maintenance in Australia, Europe, the United States of America, and other countries.

(*b*) Experimental research into the characteristics and suitability of road-making materials.

(*c*) The laying down of experimental sections in different types of materials and methods of construction, and the accurate recording of data connected therewith.

(*d*) The standardization of tests for road materials.

(*e*) The observation and recording of the effects of different kinds of traffic on various types of roads.

(*f*) The determination of speed, width of tire, and load practical for each different kind of vehicle consistent with public safety and general convenience and the normal wear of the road.

(*g*) The compilation and publication of data and results obtained from the experimental research carried out by the organization, and of information collected by it.

(*h*) The dissemination of information relating to the location, development, and construction of roads, and the preparation of maps showing the occurrence in Australia of useful quantities of road materials.

(*i*) Propagandist work for good roads, and collaboration with bodies and authorities in Australia and other countries engaged in road research and propaganda.

As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasized by every advance in science, that "Great are the Works of the Lord."

—*SIR J. J. THOMSON.*

Towns and Industry.

By EBENEZER HOWARD, The Younger.

HOUSING PROBLEMS AND EFFICIENCY.

Recently, efforts have emanated from Sydney with the object of introducing certain American methods in housing, on the plea of solving existing problems in Australia. These efforts apparently begin with the claims of certain space-saving devices and end in flats and tenements. The propagandist literature in support of the claims clearly challenges the economic and social utility of the Australian one-family detached house, and seeks to substitute a closer and denser form of building, the trend of which is towards an increase in overcrowding. The matter does not wholly concern Sydney, where the growth of flats and overcrowding has long been viewed with apprehension by those actively interested in modern housing and town planning. Propagandist literature in favour of closer building, supported by glib and specious claims, is being circulated also in other States. Some of the arguments and suggestions put forth in favour of space saving include—

(1) Any owner by adopting bungalows without bedrooms can build two houses where one existed before, and the rent derived from the one will pay interest, taxes, &c., on the other, and so he can live rent free.

(2) By adopting space saving, "wide-awake owners and investors" can put four family bungalows on an allotment at present used for one. Two houses (semi-detached) being built in rear of two fronting the street.

(3) Adoption of space saving enables bungalows to be built on narrower frontages—20 to 30 feet.

These arguments may be logical and true, but their effect in practice is obvious. For a time, at least, "the landlord doubles his profit," as the space-saving advocates claim. The public pay an increased cost for a less healthy and convenient mode of living, the effect of which upon public economy and hygiene, as well as upon children and families, is distinctly deteriorative and reactionary. Whatever savings may be effected in space are counterbalanced many times over by the higher cost that inevitably accrues where closer building is resorted to.

TENEMENT HOUSE AN EVIL—NOT A REMEDY.

If the argument in favour of space saving were confined to bungalows, the case for regulating these developments under town planning by-laws and schemes would be still incontrovertible. But when it seeks to import wholesale tenement building and apartment houses on American and Continental models into a country with the climatic conditions of Australia, and solely on the ground of commercial enterprise, the need for inquiry and action by State Governments becomes urgent and vital in the interests of the race. Take, for instance, one of the plans of tenement houses or flats circulated as a study in "conservation of floor space," and "showing what is possible on a 40-ft. x 60-ft. area." Obviously such plans are intended as an appeal to the cupidity of certain classes of investors in house building in the interests

THE TENEMENT FROM THE OUTSIDE.

FROM COTTAGE TO TENEMENT.

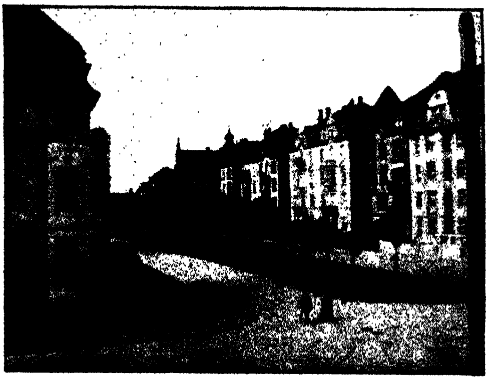
German City in process of replacing earlier types of self-contained cottages by residential tenements or flats. Working class district,

NO COTTAGES—ALL TENEMENTS.

New erected tenement housing in middle class district, where the density of persons is 800 per acre.

EVEN THE WELL-TO-DO CAN ONLY AFFORD TENEMENTS.

Uncontrolled speculation in land and building in Germany before the war had eliminated the cottage from urban life and compelled all classes (except the very rich) to live in flats.



of particular household devices. The plan shows an eight-story building, containing 40 apartment houses, built on an area of 40 feet x 60 feet. If the flats were erected on an area of 66 feet x 66 feet, the rate of building would be equal to 400 houses to the acre. If limited to the area quoted on the plan, the number of houses per acre would equal 736. Taking 400 houses at four people per house (modern flat

average) gives 1,600 persons to the acre. Compare this density, for instance, with—

Hampstead Garden Suburb (London). (Maximum density in any one area of workmen's cottages.)	50 persons per acre.
London slum	400 " "
Berlin slum	1,200 " "
Naples slum	1,400 " "
Chippendale slum area (Sydney)	324 " "
Fitzroy slum area (Melbourne)	220 " "
City of Unley (Mixed class residential area, Adelaide)	9 " " (General average.)

When the plan is examined it will be noted that each air vent shaft (4.0 x 2.6 x 8 stories in height) has to provide light, air, and ventilation to 16 bathroom-lavatories, each measuring, on the average, 6 feet x 6 feet. How can we fight "Spanish influenza" or other epidemics if this kind of housing "reform" is to be permitted?

ECONOMIC EFFECT OF OVERBUILDING.

These conditions approximate some of the worst forms of tenement building known in Europe. Their multiplication in large cities have resulted in an intensification of the problems of infant mortality, depletion of physique and public health, immorality, tuberculosis, epidemic diseases, and other costly and wasteful evils due to bad housing. They are a prolific cause of industrial inefficiency, strikes, drunkenness, and social unrest generally. It may be argued, of course, that the building of such residential flats in isolated groups for the accommodation of particular classes of people could not lead to the same results in Australia. In the initial stages of replacing self-contained houses by residential flats, the argument might superficially be true, as it appeared to be once upon a time in Germany, Italy, and France and American cities. But the incidence and experience of modern land and building speculation in all these countries (where transfer and site ownerships are not encumbered to the same degree as in England) show that isolated groups of flats do not remain. Wherever they are resorted to under speculative enterprise, economic pressure, both in land and building values, is increased. Owners of house property in built-up areas find it more profitable to replace the older forms of housing (at present common to all Australian cities) with flats. But the flats, originally designed for people of fortunate circumstances, tend to depreciate with the growth of the city and the increase in tenement building. As these people remove to other quarters, other classes take their place. It becomes only a question of time, in certain districts, when flats are converted into appalling tenement slumdom. Witness New York, Chicago, Glasgow, Berlin, Paris, Hamburg, Rome, &c., &c.

There have been present in Sydney and Melbourne for some time now those conditions of growth in the modern city whereby the transition from self-contained houses and garden spaces to flats and intensive overbuilding and overcrowding becomes economically inevitable. The process has made considerable inroads in Sydney. It is taking root also in Melbourne and Adelaide, also other cities. The adoption of regulatory measures is highly expedient in the interests of national economy and welfare, and for the purpose of promoting health, convenience, amenity, and conservation of human resources.

COTTAGES *V.* TENEMENTS.

MODERN COTTAGES WELL BUILT AND PLACED IN GARDEN SUBURB SURROUNDINGS IN ACCORDANCE WITH TOWN PLANNING AND HOUSING PRACTICE.

MODERN TENEMENTS FOR WORKERS.

Common to Continental and many American and Canadian cities, deficient in light, air, and residential amenity.

REGULATORY MEASURES OVERSEAS.

These measures nowadays are being effected in Great Britain, European, and other countries under modern town planning practice. Their adoption in Australia is necessary in the interests of industry as well as the conservation of national welfare. Industrial efficiency is dependent even more upon the efficiency of the home than the factory itself, although both are indispensable. This truism has long been recognised and given practical effect in industrial garden villages by up-to-date manufacturers, such as the Levers, Cadburys, Rowntrees, as well as by Continental and American manufacturers. It is part of the foundation of Letchworth Garden City and the modern housing movement generally. The British Government spent £6,000,000 in applying it to the many new munitions towns and factories planned and built during the war. The United States Government has spent £25,000,000 for similar purposes. Moreover, the incorporation of garden city principles and standards of housing under municipal town

or city planning schemes and ordinances is one important feature of modern civic practice in all these old and new countries (including Canada and India) that remains conspicuously absent in Australian States.

FEDERAL ADVISER REQUIRED.

Enlightenment upon and corrective to many matters affecting town or city life are required, apart from the costly evils of flats and tenement housing generally.

Some of these matters have a profound bearing upon industry and production, such, for instance, as the modern factory area equipped with special facilities for transportation by land or water, centralized power plants, housing and welfare of workers, &c. The unprecedented shortage and arrears in the national housing is another urgent problem as yet scarcely understood, but which intimately affects industry and the whole Commonwealth. These, and other urban questions, call for immediate investigation and study by town-planning and housing experts. Not only are wider knowledge and understanding of the manner in which older countries have grappled with similar difficulties required, but also expert organization and analysis of the different kinds of local problems requiring to be met in different centres.

Certain preliminary steps are being taken in several States, it is true, by the preparation of town planning enactments and the establishment of special departments. The movement has gained ground rapidly also as the result of the recent national conferences in Adelaide and Brisbane. The third conference, to be held in Sydney during 1920, will help to further stimulate, interest, and educate administrative bodies. But what, in addition, appears to be necessary is some continuous national effort in educating public opinion and furnishing expert guidance and advice generally to the State Governments and Departments seeking to adopt modern town planning and housing practice. The Federal Government of the Dominion of Canada solved the problem of supplying expert advice and educative material to the provincial Governments by attaching to the Commission of Conservation a town planning adviser of British and European experience (Mr. Thomas Adams, F.S.I.). His advice and efforts during the past five years have resulted in the passage of town planning Acts in eight out of nine provinces, and, before long, such legislation, and the practice it incorporates, will be general throughout the Dominion. Under the Canadian arrangement, experience shows that there can be no overlapping or misconception of function, whilst—

(1) the work and sphere of the Federal Town Planning Adviser are advisory and co-operative, and

(2) the functions of State Departments of Town Planning are executive and administrative.

At present, whilst much has been achieved through the Australian Town Planning Conference and Exhibition, and its Federal Council, which should now become permanent, there remains still no sustained or organized propaganda in the different States. Some central bureau of expert information and instruction is required. Clearly some adaptation of the very successful Canadian system should lead to similar permanent results in Australia. It is a matter which intimately affects the Institute of Science and Industry.

THE TENEMENT FROM THE INSIDE.

BACK YARDS, CLOTHES DRYING AREA TO SIXTY HOUSES.

Back of flats (Munich) occupied by middle class families.

BACKS OF A MODERN WORKING CLASS TENEMENT.

Density, 1200 persons to the acre. Stables, &c., in the basement.

LIGHT AND AIR COURT TO MODERN TENEMENT HOUSE.

Looking into the well of a modern eight-floored tenement (Paris).

Note the industrious housewife shaking the carpet.

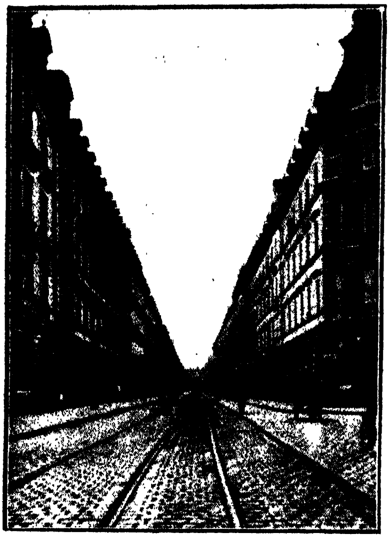
BRITISH GARDEN CITY *V.* GERMAN CITY.

FACTORY AT LETCHWORTH GARDEN CITY, BUILT ON CHEAP LAND.

Note the light and air space.

FACTORY AND DWELLINGS IN A GERMAN CITY (LEIPZIG).

Note also light and air space.



THE MODERN GERMAN WORKING CLASS DWELLING, FIVE AND SIX FLOORS HIGH, CONTRIBUTING TO ILL-HEALTH, POVERTY, AND UNREST.

THE MODERN GARDEN CITY TYPE OF HOUSING, CONTRIBUTING TO HEALTH, WEALTH, AND EFFICIENCY.

Applications of Veterinary Research: With an Example.

By Prof. HAROLD A. WOODRUFF.

(II.)

About this time Schroeder and Cotton*, two workers in the United States, recorded the occurrence of the abortion bacillus in the milk of cows. On investigation this was found to be a frequent occurrence, and Seddon has shown that in infected dairy herds in Victoria a considerable proportion of cows are voiding abortion bacilli in their milk. Further it is found that these animals may continue to eliminate the specific bacilli for many months, or even years, during normal pregnancies or sometimes accompanied by abortions. Apart from the act of abortion there are practically no symptoms, so that, judged by this criterion, there are many "carriers" of the infection and comparatively few active cases. That a large number are carriers is proved by (1) their positive reaction to the agglutination test, and (2) the discovery of the abortion bacillus in their milk.

The recovery of the bacillus from milk is effected by injecting a small quantity of milk into the peritoneal cavity of a guinea pig. In four to six weeks' time a pure culture of abortion bacillus can be obtained from the animal's spleen. Thus the large number of positive reactions to the agglutination test is quite well explained, and the test may be looked upon as a reliable guide to determine infection or non-infection.

A practical application of the test is of great value in determining whether a herd is free from the disease at a particular time, and thereafter all fresh purchases and newcomers to the herd can be tested before being allowed to mix with clean animals. For the test, there is required about 2 ozs. of blood from the suspected animal, this material being sent to the bacteriological laboratory, where the diagnosis can be made in 24 hours.

Thus it can be claimed that scientific research has solved two of the basic problems connected with the disease, namely, its specific cause, and reliable means of diagnosis at all stages of the infection.†

But a further important question now arises, namely, what are the common methods of infection?

In the first place, it may be stated, with some degree of confidence, that the disease is a purely contagious one due to an obligatory parasite. The organism of contagious abortion is cultivated artificially with some difficulty, and under special conditions, so that all the available evidence is against its being able to live and multiply naturally outside the animal body. Thus when contagious abortion breaks out on a farm it can only be as a result of infection from a precedent case of the disease.

In the second place, it appears likely that there is more than one method of transmission. For many years it was believed that the exclusive means of natural infection was by the bull in the act of copulation. But McFadyean and Stockman first showed that animals could easily be infected by the ingestion of infected material, such as discharge from a cow after abortion. Further, it is quite common to find virgin heifers which react to the agglutination test, and in these cases infection by ingestion must be considered the explanation.

* The Bacillus of Contagious Abortion found in Milk. U.S. Dept. of Agriculture, Bureau of Animal Industry, Circular, No. 216.

† In experimentally infected animals the agglutination test will be found reliable within 10 days of the time of infection.

An important point demanding careful inquiry is as to the time of infection. It is generally considered that the discharge from a recently aborted cow is the commonest source of infection. Such material may contaminate bedding material, or hay for fodder, or, out in the open, the grass, and the material so infected is eaten by other susceptible animals, which themselves become infected. If this be true, then care of the newly aborted cow, including isolation, irrigation of the genital canal with an antiseptic, and proper disposal of all discharges and soiled fodder and litter, are the obvious preventive measures.

But with the discovery that the abortion bacillus is voided in the milk of a large number of cows comes another possibility which has serious consequences. W. L. Williams, of New York State Veterinary College* has suggested that the young calf suckling may become infected by means of milk containing the bacillus, retain the infection without symptoms until pregnant, and then in a number of cases abort, or, in any case, continue to spread the infection. This possibility opens up further chances of infection, for it may often happen (on this hypothesis) that a clean unaffected herd producing milk which is sent to the butter factory, and feeding calves on the returned separated milk, will become infected by means of milk from affected herds, which also supply the same butter factory.

The return by butter factories of unsterilized and unpasteurized separated milk—the mixed milk of several cows and several herds—is a potent source of many infections, notably tuberculosis, and, on Williams' hypothesis, contagious abortion. This theory of infection has not been proved. It is a matter on which research work is being done, and the results are important. Meantime Williams advises only boiled milk for the feeding of calves, a quite effective method of prevention.

To sum up on this point, it may be stated that there are various possibilities of infection, instead of only one method as was formerly taught, and with these added possibilities the chances of infection are greatly multiplied. Special preventive measures are indicated, and special research is proceeding in many places to determine the truth on these matters. Such research, however, takes a long time, and, moreover, it is expensive, since it deals with cattle expensive to purchase and costly to keep.

One other question of considerable interest may be discussed briefly, namely, the possibility of some form of vaccination or inoculation to render animals immune to the disease. A point of importance in this connexion is that infection with contagious abortion produces no systemic reaction, as a rule, *i.e.*, there is no rise of temperature or other febrile symptoms. Again, an animal may remain infected and continue to void the causal organism, the abortion bacillus, in the milk for years. Thus, under natural circumstances, the immunity developed as a result of natural infection is of a very low order. It is true that most cows which abort do so only once, a small number may abort twice, and a very small percentage three times. It is also true that the disease in a herd tends to lessen and apparently die down in a few years if no new stock is introduced from outside. But the infection is still there, as can be proved by bringing in a few pregnant uninfected heifers.

This low degree of immunity set up under natural conditions may be the explanation why artificial immunization is not yet satisfactory. Two methods have been tried on a large scale. The first is by the use of killed cultures. Just as in the successful vaccination against typhoid fever in man, so in this

*Report of New York State Veterinary College, Connell University, 19114-5.

case the organism of contagious abortion is grown artificially and then killed, and a few million of the dead bodies suspended in sterile water are injected into the animal it is desired to immunize. After an interval of a week a second larger dose is given. Thereafter, if the method were successful, as judged by the results of similar vaccinations against other diseases, an effective immunity might be expected. Unfortunately this method has not proved effective in materially reducing the chances of abortion.

Because of this failure, McFadyean and Stockman, in England, have advised the use of living cultures of the abortion bacillus. The procedure is to administer a large dose of a living broth culture to a cow about four months before it is intended that pregnancy shall commence. It is claimed that by this method a very considerable reduction in the liability to abortion is effected. What has not been stated, but a matter of supreme importance, is whether the living organisms which are inoculated into an animal are killed off as the immunity rises, or whether they remain alive and active. In the latter case it may well be that, whilst in the majority of cases they do not produce abortion, they still remain potent to infect other animals. Experiments in the Melbourne University Veterinary School* have shown that animals experimentally infected by subcutaneous or intravenous injections of living cultures of the abortion bacillus will become infected, and will excrete the living organisms in the milk for months or years. Thus this method, even if proved to lessen the number of abortions, must be shown also to be free from the danger of producing carriers which will spread the infection. Only with widespread or almost universal vaccination of cows would such a method be warranted.

Thus it has to be confessed that no satisfactory method of prevention of infection with this disease has yet been discovered. Here is a field for research with a great economic reward for a successful harvest.

And so a brief consideration of one prevalent animal disease has shown the valuable results achieved, and the further problems awaiting solution by scientific research. This is one line of work for the veterinary scientist, but there are many others, and many that are quite untried. Two conditions are necessary, viz., (1) a supply of capable workers, and (2) money and equipment. The former condition is in process of being fulfilled. The latter will be provided whenever the persons whose interest it is think it worth while.

*Expts. by Seddon—not yet published.

Personal.

PROFESSOR DAVID ORME MASSON, C.B.E., M.A., D.Sc., F.R.S.

AN APPRECIATION.

The Melbourne University was founded in 1853, and for the first thirty years or so of its existence the place held in it by Science was one of comparative insignificance. The distinguished Sir Frederick McCoy presided over a single department with the title of Professor of Natural Science. By the eighties it had become abundantly evident that even a man of Sir Frederick's parts could not compass all that "Natural Science" had come to include, and the University appointed to its staff probably the most remarkable triumvirate that any Colonial University has ever attracted at one period. In 1886, Dr. David Orme Masson, formerly assistant to Professor (later Sir William) Ramsay, in University College, Bristol, became its first Professor of Chemistry; soon afterwards Mr. (now Sir) Baldwin Spencer accepted the Chair of Biology, and two years later, Mr. T. R. Lyle that of Physics. To these three men, who always worked in close and harmonious association, not only the University of Melbourne, but the whole of Australia, is deeply indebted for scientific services of the highest merit, and for many general public services no less creditable.

Dr. Masson was but 28 years of age at his appointment. It is unusual for a scientist to attain the dignity of a professorship so early, but the record on which the appointment was made was equally unusual. Mr. Masson was educated at the Edinburgh Academy, and later at the University of Edinburgh, where his famous father, Professor David Masson, the Historiographer Royal for Scotland, occupied the Chair of Rhetoric and English Literature. He graduated as Master of Arts in 1877, and in 1880 as Bachelor of Science. For some six months in 1879 he studied at Göttingen under one of the leading chemists of a by-gone generation, Dr. Wöhler. It was during the following year that he was associated with Professor Ramsay at Bristol, beginning an intimate friendship that only ended with Ramsay's death. Then for three years he held a Research Fellowship, and worked again at Edinburgh under Professor Crum Brown. His researches included investigations upon molecular volumes of a number of liquids, upon the action of halogens on certain organic substances known as the sulphine salts, and also upon the composition of a now very familiar chemical, nitroglycerine. In recognition of these, he was admitted in 1884 to the degree of Doctor of Science. That he at the same time took a leading part in the general life of the University, is evident from the fact that he was Senior President of the first Students' Representative Council, and convener of the committee which inaugurated the Edinburgh University Union. He was also a member of the University Buildings Committee.

When, in 1886, Dr. Masson came to Melbourne, there was practically no school of chemistry worth the name, and for the first fifteen years or so he devoted himself mainly to the task of creating a school with a tradition of sound teaching and sound research. Gradually he was then drawn more and more into that general administrative work which,

apparently inevitably, falls so heavily upon the professorial staffs in our Australian Universities. He paid the penalty of successful administration, and his sound judgment, his conspicuous ability in organizing, his unusual tact and invariable courtesy in dealing with others, soon made his presence seem indispensable when matters of moment to the University were under consideration; and the same qualities brought him more and more into big public movements outside the University. Yet he did not at any time cease to devote the major portion of his energies to his own science, and his research work has been of a brilliant standard. Only a very robust constitution enabled him to carry through some of his finest investigations, while at the same time discharging his teaching duties and bearing a heavy share of general University management. One of his lecturers once said good-bye to him in the laboratory on a Friday afternoon, and on returning on the following Monday morning, found him, as before, hard at work. "One might almost imagine you had been here ever since Friday," was jokingly remarked. "Well, as a matter of fact, I have," was the reply.

During the earlier years, Professor Masson continued, in collaboration with his assistant, Dr. Kirkland, the investigations he had begun in Edinburgh; and later he returned to the comparative study of liquids from the points of view of boiling temperatures, molecular volumes, and chemical characteristics. Always more attracted by the purely philosophical side of his subject than by mere laboratory technique, the nature of aqueous solutions particularly interested him, and perhaps his work of most importance is that published in 1899 upon the velocity of migration of ions. It was a very fine contribution to the new theory of solutions initiated by Arrhenius in Sweden, and van 't Hoff and Ostwald in Germany, and marked Dr. Masson as one of the leading exponents of the new school of thought. There followed a series of papers upon allied problems of solutions, chemical dynamics, methods of analysis, and other subjects; and the series, we may hope, is still far from completed. In 1903, his work received the chief recognition of sterling merit that a scientist can gain from his colleagues, election to the Fellowship of the Royal Society. Many of his students have attained high honours. Two of them—Dr. B. D. Steele, F.R.S., and Dr. N. T. M. Wilsmore—are Professors of Chemistry in other Australian Universities, and many more are scattered amongst Colonial and Home Universities. Quite a large number were engaged in administrative and operative positions during the war under the Ministry of Munitions.

Though the administrative work falling upon every professor in an Australian University is considerable, the chief weight of it is borne by the President of the Professorial Board. At Melbourne, the duties are such that the President takes the leading part in all legislative work, and in a great deal of the executive work of the governing bodies, Council and Senate. Practically, he is the temporary Principal of the University. For four years, beginning in 1912, Dr. Masson held this office. They were years during which considerable changes were effected, not only within the University, but also, through the Schools Board, in its relation to secondary education throughout the State. Dr. Masson took the lion's share in it all, and these years not only fully confirmed but increased his reputation for devising bold, constructive policies, and for powerful and lucid advocacy of any course he deemed the best.

His absences from Australia have been rare. One of the longest was in 1901. A project had been mooted for an Indian Institute of Science. Dr. Masson visited India at the request of the Council in charge, and, in collaboration with Lt.-Colonel Clibborn, C.I.E., advised upon all aspects of what was a difficult problem. The Institute has now for many years been carrying out good work at Bangalore, in Mysore.

In 1912, when Sir William Ramsay resigned his position in the University of London (University College), an invitation was given to Professor Masson to succeed him in what is, perhaps, the most famous Chair of Chemistry in the Empire. Fortunately for the University of Melbourne, Dr. Masson did not see his way to accept what must have been a very attractive offer.

To the Professor's general public work it is impossible in a short space to do justice. The briefest summary of his activities during the past ten years must suffice, and no special reference will be made to the various Government Commissions and Boards upon which he served.

From 1911 to 1913 he was President of the Australasian Association for the Advancement of Science, and in that capacity was one of the leaders in organizing the Australasian Antarctic Expedition, which achieved such valuable scientific results under Sir Douglas Mawson's direction. Dr. Masson was chairman of the committee which supported Mawson, and was throughout concerned with every detail of the project.

During these same years the idea of inviting to Australia the British Association for the Advancement of Science took shape. The negotiations with the various Governments of the Commonwealth and the States, and with the Association leaders in England, were successfully carried through, and the meeting was held in the various capital cities in August, 1914. The conditions of those days are fresh in the memory of all. The meeting was probably one of the most successful attempts yet made to forward that growth of knowledge of one another which is so imperative a necessity between the constituent parts of the Empire. From first to last, Professor Masson, splendidly supported by his colleagues in all States, led the movement, and, as Chairman of the Executive Committee responsible for the required organization, his was the guiding hand throughout.

The war, of course, brought new work to him. He became a consulting member of the Federal Munitions Committee; he took an active part in the work of the Universal Service League. But his chief labours began when the Prime Minister invited him to act as Chairman of the Committee appointed to advise the Government on the proposed foundation of an Institute of Science and Industry. The history of this Committee, under Dr. Masson's guidance, and of others formed on its recommendation, of the broad basis designed for the permanent Institute, and of the great amount of preliminary scientific investigation carried out, is familiar to all interested in this admirable and most necessary development.

Nor, in these days of rapid change in status of the chemical profession, must one omit to mention the effort he has made, and is making, to place the profession in Australia on a sound footing. The new Australian Chemical Institute is very young, but it is flourishing and full of promise, and the profession will be under a great debt ere long to the leader who has been chiefly instrumental in organizing it.

PERSONAL.

But there are many to whom the character of Dr. Masson makes more appeal than the works which are its inevitable expression. "The charm of a most inspiring personality," said Mr. Alfred Deakin on one occasion, "always and everywhere surrounds Dr. Masson." It is because of this that he is revered by his students and honoured by his colleagues and associates within and without the University. The well-balanced intellect, keen sense of justice, lucidity of thought and speech, quick sympathy, exceptional tact and dignity of presence which are so marked in him, have made him an influence in the country which we may hope not to lose for many a year to come.

Mr. A. E. Leighton, Director of the Commonwealth Arsenal, has been appointed a member of the Executive Committee of the Advisory Council of Science and Industry.

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Professor B. D. Steele, of Brisbane, is one of the fifteen new Fellows of the Royal Society. He has been made a member of the Advisory Council of Science and Industry.

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Mr. Ewen McKinnon, B.A., B.Sc., Assistant Biologist to the New South Wales Department of Agriculture, has been appointed Science Abstractor to the Institute, in place of Mr. W. B. Alexander, M.A.

—o—

Dr. J. A. Gilruth, Administrator of the Northern Territory, has sailed abroad on six months' leave. While in the United States he will investigate, on behalf of the Institute, the means being taken to eradicate cattle tick there.

—o—

Sir Douglas Mawson addressed members of the Executive Committee of the Advisory Council during the month upon the subject of Fuel Economy.

—o—

Mr. Gilbert Rigg was present, by invitation, at a meeting of the Executive Committee held on the 21st April last. Mr. Rigg spent a number of years in the United States, where he was associated with the work of the American Society for Testing Materials. He furnished an interesting account of the organization, work, and methods of that society.

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Professor A. J. Perkins, Director, Department of Agriculture, Adelaide, has been appointed a member of the Advisory Council of Science and Industry. Professor Perkins was Chairman of the Inter-State Conference of Agricultural Scientists convened by the Institute in November, 1917.

—o—

Professor C. E. Fawsett, D.Sc., Ph.D., a member of the Advisory Council, has been elected President of the Royal Society of New South Wales for the ensuing year.

—o—

Dr. Colin E. McKenzie has returned from munition making at the cordite factory at Aruvan Kadu, South India, and has resumed his post of lecturer in chemistry at the Royal Military College, Duntroon.

Mr. C. S. Nathan, a member of the Executive Committee of the Advisory Council of Science and Industry, left for the United States by the *Ventura* this month.

—o—

Mr. C. C. Brittlebank, of the Victorian Department of Agriculture, has been appointed to act as Vegetable Pathologist in connexion with the viticultural investigations which are being carried out by the Institute in Mildura.

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Mr. G. Tattersall has been appointed Secretary of the Western Australian State Committee of the Advisory Council in place of Mr. I. H. Boas, now in the United States on the Institute's business.

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Mr. A. E. V. Richardson, Superintendent of Agriculture, and Mr. P. Ryan, Travelling Inspector, Department of Agriculture, Victoria, have been added to the Special Committee which is carrynig out the investigations on castor beans.

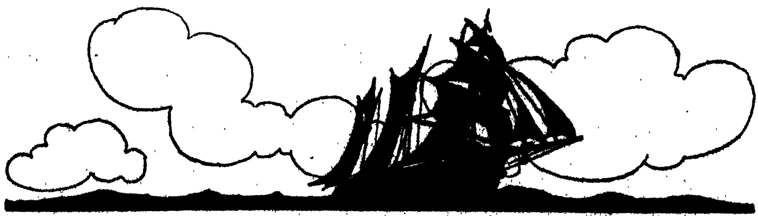
—o—

Mr. H. Wardale-Greenwood, M.A., has been appointed as secretary of the Commonwealth Bureau of Commerce and Industry. Prior to his enlistment in the A.I.F., Mr. Greenwood was secretary and manager of the St. John Ambulance Association, and Red Cross Director for Victoria. Mr. Greenwood enlisted in 1916, and gained his commission in France in 1918. He served with the 38th Battalion, and was wounded at Peronne.

If we are to build up our universities for honorable competition in the service of the world, the research man must be continually on the job.

In no other way can we hold that leadership which will enable us to discharge our debt to the world and to develop our countries for the betterment of our people and the world at large.

—***PROF. HENRY B. WARD***
(University of Illinois).



HENLEY'S RECIPES AND PROCESSES.

A VALUABLE COLLECTION.

To compile a book of recipes and processes so diversified and yet so detailed as to meet the practical requirements of the home and the workshop, is an ambitious undertaking. Yet the task has been accomplished. By a careful selection of material, the editor (Mr. Gardner D. Hiscox) of **Henley's Twentieth Century Formulæ, Recipes, and Processes,* succeeded in preparing a compendium of information which has proved of real value to a wide range of inquirers.

After a lapse of nine years, a new edition has been issued, with the object of keeping pace with recent developments and of presenting the most modern methods. The manner of the presentation of the information, however, has undergone no alteration, nor was there any need for departure from it. Processes of questionable merit Mr. Hiscox claims to have discarded, while retaining, of course, recipes which have proven their value by long use.

The large number and variety of subjects which are dealt with necessarily impose the strictest limitation of space. It is manifestly impossible to describe a complex scientific process in a few words, and it is not intended that the material and data collected shall be regarded as an exhaustive treatise upon any subject. In many cases, however, the editor has given an interesting "Bird's-eye view" of a subject, and directions how to proceed in the thousand and one chemical processes that are given, although brief, are sufficiently clear and explicit as to be readily followed. Painstaking care also has evidently been given to the selection of the formulæ and recipes intended for the housewife, the home, and farm worker, and the mechanic. The long list that is given of some of the authorities who have been consulted in making the abstracts, and the numerous translations from foreign technological periodicals, indicate the industry and thought bestowed upon the preparation of the volume.

In all, ten thousand formulæ, recipes, and processes are included in the 800 pages which the book contains. Commencing with a number of formulæ for acid proofing, Mr. Hiscox then devotes several pages to adhesives, which deal with glues, cements for all purposes, including leather and rubber. Formulæ for seemingly every kind of alloy form an important section, while recipes for beverages comprise another section. Then, taking a few of the headings at random, come brass, brick, ceramics, cleaning preparations and methods, corn cures, cosmetics,

* Our copy from Angus & Robertson Ltd., Sydney. Price 15s., post free 15s. 8d.

disinfectants, enamelling, essences and extracts, etching, food adulterants, glass, hair preparations, inks, lubricants, milk, oils, perfumes, photography, plating, polishes, salts, soaps, solders, steel, varnishes, veterinary formulæ, waterproofing, wines and liqueurs, wood, and yeast.

All the formulæ and recipes are culled from standard reference works, such as pharmacopiæ and technological works, and in outlining various processes well-known authorities are quoted. Mr. Hiscox, however, advises, in a prefatory note, that each recipe is to be regarded as a basis of experiment, to be modified to suit the particular purpose in hand, or the peculiar conditions which may affect the experimented. Chemicals are rarely of uniform relative purity and strength; heat or cold may markedly influence the result obtained, and lack of skill in the handling of utensils and instruments may often cause failure. These points must be borne in mind. Inasmuch as a particular formula may not always be applicable, several are given from which a suitable selection may be made. One at least should answer the purpose.

WHAT INDUSTRY OWES TO CHEMICAL SCIENCE.

A series of articles contributed to *The Engineer* in 1916-17 by Messrs. R. B. Pitcher and F. Butler-Jones has lately been published in book form under the title* *What Industry owes to Chemical Science.* In an introduction to the little volume, Sir George Beilby points out that the records compiled by the authors supply a complete answer to the very common questions—what is the place of the chemist in practical life, and what part has he taken in industrial and social development? It is a graceful appreciation of labour which is conducted in the background, "inobvious, and little, if at all, understood."

The purpose of the articles was to show by concrete examples how science has advanced the methods and processes of production, and has laid the foundation for the establishment of new manufactures. The authors have, therefore, set forth, without any effort at literary embellishment, the broad facts of achievement. Should these facts in themselves fail to interest, the reader will derive no other pleasure from the book. As Sir George Beilby points out, "the precious stones in the necklace have been strung together rather with an eye to their collective preservation than to their artistic effect as a whole." Almost the whole range of production has been covered, the subjects having been grouped under nineteen headings. The volume contains much that is of value to the teacher and to the student. It should also appeal to a large section of the public.

*Our copy from Peter G. Tait, 90 William-street, Melbourne.

Correspondence.

SCOPE OF MAGAZINE.

To the Editor.

SIR,

I have received the first copy of your magazine, entitled as above; and I have read your "Foreword" with interest, in order to ascertain the scope of its journalistic outlook. Your opening sentence, containing the phrase "Scientific thought and aspirations," for which it is to be a medium of expression, at once suggests a very wide purview; and the only doubt that can now exist is as to whether, and at which point, you are going to place an editorial limit on the subjects to be discussed in its pages. For "science" itself is a sufficiently wide term; and when it is coupled with the word "aspirations," which takes in so much that is beyond the domain of "knowledge," the scope foreshadowed seems to be almost limitless.

So far, your contents are largely pastoral, agricultural, or mineralogical; the matter being somewhat similar to that which might be found in the magazines issued by the Mines and Agricultural Departments of several of the States; but I apprehend that you will amplify your journalistic "menu" in later issues.

I have been wondering whether, having used these comprehensive terms, you will consider that articles on political, economic, and moral science come within the scope of the magazine; for there is a real want, in Australia, at present, of a medium of expression in regard to such subjects. Many years ago, the *Melbourne Review* and the *Victorian Review* afforded such a channel for public opinion; and I am sure that if you were to look through the "Table of Contents" of those magazines, now unfortunately extinct, you would see, and acknowledge, that they contained many articles, under the heads I have named, which were of great intellectual value, and which would do credit to any of the greater British or American magazines of to-day; and I am sure also that if you had examined some of the contents of those two magazines, you would not have said that "there is a paucity of trained men" in Australia; at least, in regard to those subjects. My own opinion is that, given a proper medium for literary expression, which our daily ephemeral newspapers do not supply, it would be found that Australia could excel, in intellectual force and originality, as unmistakeably as she has done in her soldiering; for our climate, and environment, and isolation, afford distinct aids to intellectual initiative, as they do to the practical faculties that have so distinguished our soldiers.

The opening of your columns to the subject of "Economic Science" would admit a number of articles in criticism of, or in vindication of, our nondescript tariff, which, at present, is the battledore and shuttlecock of politicians and Chambers of Manufactures; it would admit contributions on the subject of our unscientific methods of taxation in States and Commonwealth, portions of which have already been vigorously and scientifically attacked by Professor Carslaw of the Sydney University, without receiving a scientific answer.

Such a scope would admit articles in regard to the relative merits of "Preferential" and "Proportional" systems of voting, and afford room for criticism in regard to the economically wasteful overlapping of Savings Bank facilities by Commonwealth and States.

All these are subjects within the scope of the term "science," in its economic side; and your magazine would open up a wide and far-reaching journalistic vista, and possibly become a publication of wide-spread influence, beyond Australia, if you and your Advisory Council see your way to allow others to enter upon the discussion of such problems; for you have carefully guarded yourselves against responsibility in your "Editor's Notes."

If you do not so intend, then you ought to at once modify the title of your magazine, as well as your extensive programme of "intentions," as set out in your "Foreword."

I should like to add that, as soon as you begin to deal with these questions fearlessly, your magazine's independence of Governments and Ministers—whether Federal or State—will be put to the test; for if you, or your Advisory Council—of which the magazine professes to be the official organ—allow the idealization of truth, as the objective—at all costs—of true science, to be interfered with, because it may not be palatable to the "powers that be," you may at once discard the wording and the spirit of your magazine title.

Yours, &c.,

BRUCE SMITH, K.C., M.P.

Commonwealth Parliament,
Melbourne.

When our local Department of Agriculture was established 27 years ago with a small scientific staff consisting of a vegetable pathologist, botanist, entomologist, and chemist, there was just the same shaking of wise heads as one anticipates now. Certainly the farmers, who were to benefit the most from the future operations of the young Department, were amongst its most scornful critics. The idea that the scientific man could be of any assistance to the so called "practical" farmer was considered ridiculous. Surely the old cow knew better what kind of food was good for her than did the chemist with his "balanced rations," and so the old cow went on "blowing" herself on clover or ate immature sorghum and poisoned herself with Prussic acid.

—F. B. GUTHRIE.

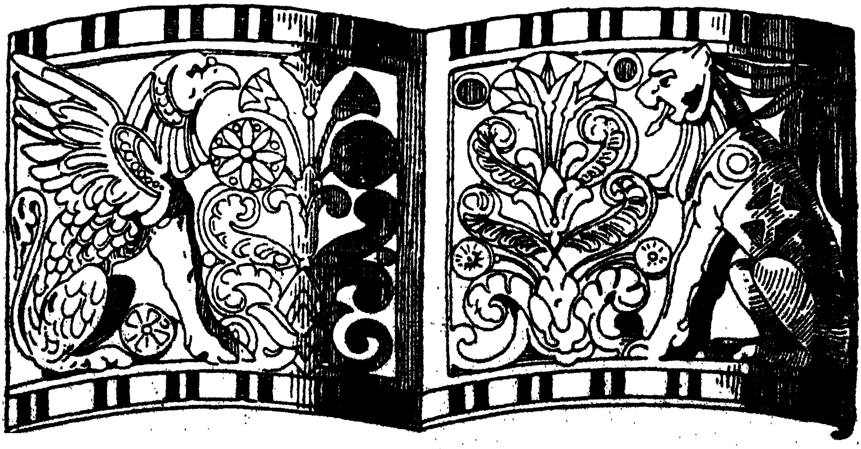


Photo by Broothorn.

HON. W. MASSY GREENE, M.P.
Minister for Science and Industry.

SCIENCE AND INDUSTRY.

VOL. 1.] JULY, 1919. [No. 3.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

The Institute and the States.

THE relationship of the Institute to the States is one of considerable interest as well as practical importance. So far the States have not been of one mind as to their correct attitude towards the youngest and newest activity of the Commonwealth. Some receive it with open arms, aid it in its endeavours, freely place their skilled scientific men at its disposal, find some portion of the money that its work necessarily demands, partake to the full of the fruit of its researches, and in every way co-operate with it, and regard it as one of the most beneficent agencies of the Federal Government. Others seem inclined to spurn its advances, to regard the scientific work they are now carrying out as self-sufficient. At the bottom of this conflict of view rests two entirely dissimilar motives. The well-worn "State rights" attitude, purely political in its origin, is one, while a certain timidity on the part of some half-trained official scientists is another. These latter fear that the coming of the Institute may in some way lead to the discovery of their incompetency. Taking scientists as a body, it may be said that every properly-trained man in Australia—and we know of no exception—is warmly in favour of the Institute. They feel that its advent will tend to set science upon a higher plane. They see visions of science at last occupying that exalted position in the hearts and minds of Australians that it should occupy. They look eagerly to the day in which capable scientists shall at least be placed on the same footing financially as the successful grocers or prosperous ironmongers.

Moreover there are several types of scientific problems that the Commonwealth alone can tackle, either (1) because they are so widespread, and have no regard for mere State boundaries, as for example

the tick pest, or (2) because they are of such far-reaching importance as to demand the full weight of the Commonwealth's resources, as for example the prickly pear problem. No State single handed can hope to solve these problems. They will tax the ingenuity of the best minds of the continent.

Still another point is the necessity for preventing undue overlapping of effort. To some extent overlapping has its beneficial side. Different minds tackle similar problems from different angles, and no one can say beforehand in which direction solution lies. But overlapping can be carried to ridiculous extremes. There is much scientific work that need be done once only. It would be absurd to put a scientist, for scientists are scarce, on to precisely the same problem in each State. Yet that is what to some extent is happening to-day, and that is one of the weaknesses of our system of research that the Institute proposes to remove. This magazine will help on the process by keeping scientific workers informed of the labours of their confrères throughout the Commonwealth.

In the past the States too often forgot their scientific workers. They employed too few of them, at niggardly salaries, and gave them little or no money to spend upon laboratories, apparatus, or books. Then, having sown a mere handful of seed, they looked for a great harvest all at once. If they were disappointed, they said that their individual scientists were lazy, or incompetent, or both, or they blamed science in the abstract as being academic and impracticable. If their investment of a few pounds in Tattersall's sweep of science did not forthwith produce a winner, then science had failed, according to their view. When the dour days of retrenchment came along—as periodically they ever come—research work had to be cut off because routine work must continue, and there was not money for both. Where, despite all these drawbacks, one or other scientist made good—as was the case with Farrer, of wheat-breeding fame— they paid him a pittance of a wage during his lifetime, and gave him a tardy recognition after his death. Here is a man who has added millions sterling to the wealth of Australia. Though this is universally recognised, his successors are being treated precisely as he was treated by unthinking and unimaginative Governments. No scientist worthy of his salt fears the coming of the Institute, but rather welcomes it. Where fear is present it is usually allied to conscious charlatanism. The incompetent fears the laying bare of his incompetency. That there is quackery in science as there is quackery in medicine no one doubts. And the force that threatens to show up the quack will not be beloved by the quack. How could it be?

There is room for all in the wide fields of scientific endeavour. Those who realize how much work there is to do are eager to extend the right hand of fellowship to every new worker. The task is so big, the problems are so complex, that there is work for all, and to spare. Scientific work knows no completion. The labourers in this field may every now and then pause and take stock—that is all. Take the text-book on chemistry published 25 years ago and compare it with the text-book of to-day. Science never rests; never stands still. Every hill of knowledge that is climbed merely opens up new vistas for research. There is no end to the curiosity of the mind—no limit to the possible stock of human knowledge.

F.M.G.

EDITORIAL

STEEL STANDARDIZATION: A SUCCESSFUL CONFERENCE.

Highly satisfactory results attended a Conference held at the Institute of Science and Industry on 1st and 2nd July, to consider the standardization of Structural Steel Sections. The invitations were issued by the Bureau of Commerce and Industry, but, in view of the active interest taken in the whole question of standardization by the Institute, the latter organization was requested to direct the proceedings. Professor Lyle presided over a representative gathering of engineers and manufacturers, the following being present: Messrs. Stirling Taylor (Director of the Bureau of Commerce and Industry), J. Vicars (Engineering Association, New South Wales), B. J. Smart (Public Works Department, New South Wales), C. Hoskins (J. and C. Hoskins, Lithgow), W. J. Doak (Institute of Engineers and Railways, Queensland), D. Gray (Gray Bros. Pty., Victoria), E. E. Lucy (New South Wales Railways), E. Campbell (E. Campbell and Son, Victoria), E. A. Evans (Government Railways, Western Australia), W. E. Goode (Forman, Long, and Co., South Melbourne), A. A. Goudy and T. D. Doyle (Victorian Railways), A. F. Pritchard (New South Wales Institute of Architects), E. Lewis and R. Rowe (Broken Hill Pty. Ltd.), W. Somerville (Institute of Architects, New South Wales), E. A. Bates and H. W. Tompkins (Institute of Architects, Victoria), T. Hill (Works and Railways, Victoria), S. W. B. McGregor (British Trade Commissioner), P. G. Tait (Commonwealth Works Department), W. P. Chancellor (Johns and Waygood), C. S. Brittingham (Victorian Public Works), and H. W. Curchin (Commonwealth Ship Construction). The main purpose of the Convention was to determine the minimum number of structural steel sections that will meet general requirements, and which, at the same time, can be rolled economically in Australia, and with this point settled, to agree upon specifications of the steel to be used, with the chemical and physical tests required. The importance of the subject was indicated by Professor Lyle who, at the outset, pointed out that the annual consumption of steel in Australia was from 600,000 to 800,000 tons, while only from 200,000 tons to 250,000 tons are produced in Australia. To help bridge that enormous gap, and make the Commonwealth self-supporting as concerns this basic industry, is one of the aims of the Institute. This object can only be attained by reducing the number of sections that users will demand from the makers. The reduction will, of course, involve the steel producers in less expense in rolling, and the users will reap the benefit in lower cost. Another point emphasized by the Chairman was that, although the decisions arrived at could not be enforced, both the Bureau of Commerce and Industry and the Institute of Science and Industry would throw the full force of their influence behind the recommendations arrived at,

and would urge upon Government, and upon all public bodies, the acceptance or recognition of the standards and specifications agreed upon.

The Conference decided upon a series of structural shapes, and Australian manufacturers will therefore be enabled to supply a much greater portion of the Commonwealth requirements than hitherto. As these requirements increase, it will be necessary to revise the list from time to time, and Professor Lyle therefore intimated that, in the course of a year or two, other Conferences would need to be held, probably, in Sydney or one of the other capitals.

A Conference of engineers of the Commonwealth and State Railways with steel manufacturers is being arranged by the Institute of Science and Industry for 30th July, to consider certain points in regard to specifications for railway lines; and another Conference is being convened for 4th August, at which engineers of the various tramway organizations will be invited to discuss the standardization of tramway rails.

COTTON GROWING IN AUSTRALIA.

It is anticipated that the possibility of permanently and finally establishing the cotton growing industry in Australia will be thoroughly tested in the near future. The Queensland Committee of the Institute of Science and Industry recently appointed a special committee to inquire into the various aspects and problems of cotton cultivation, and a strong *personnel* has been secured. It consists of Mr. E. G. Scriven, Under Secretary, Department of Agriculture and Stock; Professor B. D. Steele, Brisbane University; Mr. Norman Bell; Mr. Daniel Jones, Instructor in Cotton Growing, Department of Agriculture; and Mr. J. B. Henderson. Mr. A. E. Leighton, Director of the Commonwealth Arsenal, and a member of the executive of the Advisory Council of the Institute of Science and Industry, has greatly interested himself in the subject of cotton-growing, as it is desirable, from the point of view of national defence alone, that the Commonwealth should produce enough cotton waste for the manufacture of its cordite. The Hon. W. Lennon, Minister for Agriculture, Queensland, is stimulating interest in the industry, and on his appearances in public seldom fails to "talk" cotton.

POTTERY TESTS IN WESTERN AUSTRALIA.

Satisfactory results have attended the investigation of the Special Committee inquiring into the quality of pottery clays of Western Australia. A very large number of samples, obtained from various localities have been tested, and considerable public interest has been aroused in the initial experimentation. On one occasion the Mayor of Perth and the city councillors, together with representatives of the Chamber of Manufacturers, visited the laboratory, where they were met by the Hon. R. T. Robinson, Minister for Industries. They expressed high appreciation of the work that has been done. A syndicate which has erected a trial plant for the manufacture of domestic white ware, has been in constant touch with the laboratory during the early stages of its development, and has received advice as to the materials and the manipulation of the clays. Endeavours are now being made to

convince local potters and brickmakers of the advisability of using some form of temperature indicator in their kilns. The work, which was originally projected, having been completed, a final report is now being prepared. In connexion with this work, the Western Australia Government and the Institute is each finding a moiety of the cost.

PROHIBITIVE IMPORT DUTY ON LITERATURE CONTAINING ADVERTISEMENTS.

Uneasiness, amounting almost to alarm, has been caused in science circles by the rumour that the Commonwealth Government intends to impose a prohibitive duty on literature which contains advertisements. Such a course, it is felt, would seriously handicap scientific workers in Australia, as they are assisted largely by the developments of research in other countries. The Royal Society of New South Wales has taken up the matter, and has asked the Institute of Science and Industry to press for the abandonment of the proposal. In a letter to the executive it pointed out that such restrictions will have the effect of shutting out many valuable books and periodicals from Australia, and. therefore, will act in a most injurious way towards the progress of education and science in the Commonwealth without conferring any compensating benefit. The circulation of publications issued in Great Britain, Europe, and America is, of course, considerable, but the volume of it which reaches Australia is such a small percentage of the whole that publishers would not think of deleting advertisements simply for the extremely small advantage of maintaining Australian trade. Under present conditions the cost of books is very heavy, and scientific bodies have an extensive system of exchanges. The effect, therefore, would be to starve the Australian libraries, and reduce their value in a most disastrous manner.

VALUE OF TECHNICAL ADVERTISEMENTS.

There are other aspects of a proposal such as this. Apart from the knowledge contained in the articles of scientific publications, there is often considerable practical value in the advertisements which appear. Both science and industry would receive serious hurt if restrictions were placed upon the circulation of technical journals. Many a subscriber looks to the advertising columns for helpful suggestions, and new ideas, and he employs these in the advancement of his business, and consequently for the furtherance of Australian trade. To regard advertisements simply as an enticement to buy a foreign-made article is wrong. Our manufacturers frequently adapt an idea so gained from the advertising columns of a trade journal to their own requirements, and the Australian engineer who gets the resultant order shares the benefit. The executive committee of the advisory council, when the letter of the Royal Society of New South Wales came under their notice, expressed the opinion that not only would work in all fields of scientific research in Australia be retarded, but that technical and manufacturing industries of the Commonwealth would also materially suffer if such a proposal were given effect to.

INTERNATIONAL RESEARCH COUNCIL.

The International Research Council bids fair to become an important scientific body which will, as its name implies, perform important work of an international character. During the war a great deal of co-operative scientific work was performed by scientists of the Allied countries in connexion with war problems, and it is intended now to perpetuate that co-operation, and apply it to the problems of peace. A communication has been received by the Royal Society of New South Wales from Professor A. Schuster, Secretary of the Royal Society, London, intimating that Australia is invited to join the International Research Council. It is intended to hold a conference in Sydney on 21st August next to consider Australian action and representation, and it will be attended by delegates from the Royal Societies of the different States, and from other scientific bodies. Dr. Gellatly and Professor Orme Masson will represent the Institute of Science and Industry, and if one or other of these gentlemen are unable to attend, Mr. Leverrier, K.C., Chairman of the New South Wales Committee, will be asked to take his place.

POWER ALCOHOL.

Wide interest is being shown by engineering experts in the result of the tests made by the special committee on alcohol fuel and engines, which were published by Mr. W. N. Kernot in the last number of *Science and Industry*. The motor trade in particular is bestirring itself in the matter, and at a recent Inter-State conference of motor traders the potential value of the experimental work was keenly discussed.

At the request of the Motor Traders Association of South Australia, it was decided by the special committee to send the mechanic who assisted in the investigations to Adelaide, in order to demonstrate the alcohol engine running, and to give such other information as might be desired.

RABBIT EXTERMINATION BY POISON GAS.

A proposal, which recently was widely circulated, and which, because of its apparent simplicity, aroused a great deal of interest among pastoralists, was that the extermination of rabbits should be systematically undertaken by means of chlorine and other poisonous gases. The scheme provided for the employment against the pest of all the paraphernalia of gas attack in war. An expression of opinion upon the suggestion was sought from the Institute of Science and Industry, and it was pointed out that the scheme was impracticable, being the outcome of incomplete information about gas warfare, and implied also misapprehension as to its objects, methods, and effects. In warfare, a gas attack is successful if it forces the enemy to evacuate a position and retire, and it can hardly be supposed that rabbits would be more unwilling to run away than trained soldiers. Clouds of poison gas on a large scale, if destructive of rabbits, would inevitably be quite as fatal to birds, and little, if any, less fatal to sheep and cattle. The poisoning of rabbits in their burrows is a well-known method of attack, and is profitable in particular areas that are properly fenced to prevent reinfestation, but it offers no prospect of complete or wide-spread eradication.

POISON GASES AND FARM PESTS.

The utilization of poison gases upon a large scale in the recent war has prompted in the lay mind many speculative suggestions as to its adoption upon a commercial basis as a means of attack upon many of the pests that inflict loss upon our primary industries. Long before the war, however, scientists had given close consideration to the question, and fumigation was a firmly-established practice for the destruction of various farm and orchard pests. The efficacy of various gases for killing rabbits had also been tested, and the conclusion was arrived at that in Australia carbon bisulphide was, for all practical purposes, the most suitable. Its use, however, was not advocated for general adoption, being applicable only in certain circumstances. In this experimental work, the Vermin Destruction Board of Victoria has tested a number of gases, and has reached the conclusion that where gas is applicable, commercially, carbon bisulphide gives the best results.

SCIENCE IN THE SCHOOLS.

Mr. James, New South Wales Minister for Education, says few people have any idea of the great development that has taken place in regard to the teaching of science in the public schools during the past five years. In 1913 only 320 pupils passed the public examinations in science, whereas in 1918 the number had grown to 2,441. At the end of 1918, 8,350 boys and girls in the high schools were undergoing a four years' course in science, while 1,393 boys and girls were taking a two years' course in the junior technical superior schools and the evening technical schools. Thus nearly 10,000 boys and girls are being definitely taught chemistry, physics, botany, geology, zoology, or the agricultural sciences. Of these pupils, over 4,000 were studying more than one branch. Chemistry attracted 7,261 students; 5,724 were undergoing a systematic course of instruction in physics; 1,554 were studying botany; 289 were studying geology; 171 the agricultural sciences, and 18 pupils were taking zoology. "In 1913," said Mr. James, "62 teachers were attending day lectures at the University, and of this number only nineteen were taking the science course. Last year 253 teachers attended day lectures, and of these considerably more than half—to be exact, 141—were studying for their science degree. I intend to call a conference of scientific experts of the different industries at an early date, and propose to ask them to give the Department practical advice on the science curriculum in all our schools, and the chance of placing students who undergo a definite course of study in the secondary schools, as well as those who proceed to graduation in the Faculty of Science at the University."

RESEARCH WORK IN CANADA.

So that Canada may line up in the van of nations bidding for the world's trade, and afterwards keep in the forefront as competition grows keener, the Honorary Advisory Council for Scientific and Industrial Research recommends the expenditure by the Government of £100,000 to construct a four-story building of the laboratory type to serve as a Central Research Institute, with the functions of a Bureau of Standards,

and with such ample accommodation and equipment for research as the most progressive aspirations of Canadian industry may require. The imperative need of Canadian industries applying the most advanced technical and scientific knowledge derived from research to their problems of raw materials and industrial processes is pointed out, and the lesson enforced by showing the immense sums being spent in the United States and England along these lines.

The War being now over, the Hydrogen Committee, formed at the instigation of the Imperial authorities, has been dissolved.

At the request of the Motor Traders Association of South Australia, a mechanic has been sent from Melbourne to Adelaide to instruct members how to alter their engines to enable them to use alcohol.

A Bulletin on "The Prickly Pear in Australia," by Mr. W. B Alexander, M.A., has been published by the Institute.

An Inter-State Conference of engineers and others interested, to consider the advisableness of standardizing railway rails and fish-plates, has been convened for 30th June, at the offices of the Institute, in Melbourne.

A similar Conference, to deal with the standardization of tram rails, has been called for 4th August, at the same place.

Under the will of the late T. W. Adams, Canterbury College receives a gift of land valued at over £2,000 for the establishment of a school of forestry.

Those seeking information are invited to visit the scientific and technical library of the Institute, at Danks Buildings, Bourke-street, Melbourne.

It is hoped that before long similar libraries will be established in the other capitals.

The Director recently visited New South Wales and Queensland in connexion with the affairs of the Institute.

What Japan is Doing: Her Encouragement of Science.

The idea long cherished by some of the scientific men in Japan of establishing a National Institute of Scientific Research has, in part at least, been realized—in part, first, because the Institute of Physical and Chemical Research, which came into existence as a legal body in March, 1917, does not, as its name implies, cover the whole field of science; and, secondly, because the fund now being raised in its support is not quite sufficient to place the Institute upon such a financial basis as was at first contemplated. Nevertheless, it promises a fair start, and, with wise administration and a judicious choice of the staff, it is hoped that the Institute may do some useful work for the progress of science and industry.

The outbreak of the great war in 1914, which at once cut off the import, mainly from Germany, of dye-stuffs, drugs, and other products of daily necessity, and at one time almost gave rise to a panic in business, was responsible for producing a profound change in the mental attitude of the Government officials, the business men, and, in fact, the whole nation towards science. Those who had in vain been preaching the supreme importance of cultivating science with all activity, and pleading for public support, now saw at once that the right opportunity presented itself, and lost no time in drawing up a definite plan for an Institute of Physical and Chemical Research—a plan which, though not ideal, was deemed to be practicable and to meet the most urgent need. This, fortunately, obtained the cordial support of some of the most influential and public-spirited of the business men, particularly of Baron Shibusawa, and afterwards also of the Government, of which Count Okuma was at the time Premier.

According to the plan, which was ultimately adopted, a fund of 5,000,000 yen (£500,000) was to be raised by public subscription. Of this sum just about one-half has already been promised, and is being paid in, almost wholly by those who have either commercial or industrial concerns in Tokyo and Yokohama. The other half is, with good reason, expected to be contributed within a few years by those in Osaka, Kobe, and other large and wealthy cities in the south-western districts. The plan also included an application for a Government subvention, and, in accordance with the Bill passed by the Diet in its 1915-16 session, the Government is giving the Institute a subvention of 2,000,000 yen (£200,000) in ten years, whilst H.M. the Emperor has made a gift of 1,000,000 yen (£100,000) for promoting the object of the Institute. The total fund, supposing that the public subscription comes up to the expected sum, would thus amount to 8,000,000 yen (£800,000), of which about 2,500,000 yen has to be invested in land, buildings, and equipment. But since the interest accruing from the funds is calculated to exceed the annual expenditure for the first six or seven, or even more, years, when the activity of the Institute cannot of necessity be very great, it is expected that at the end of ten years there will be left over a fund of about 6,000,000 yen (£600,000), which, calculated at 5 per cent. interest, would yield an annual income of 300,000 yen (£30,000). To this extent, therefore, the Institute would be self-supporting, and it is roughly estimated on this basis that the number of staffs of all grades and of mechanics, laboratory boys, &c., would be between 100 and 120 in all. But it is evident that the Institute must grow in both size and activity, and that, therefore, the above income would soon be found to be inadequate to meet the necessary expenses demanded by this growth. As the Institute grows in activity, however, its importance will be made more and more evident, and it is believed that there would then be no great difficulty in obtaining more money.

Passing from the financial aspect of the Institute to its organization and work, it may be mentioned that its administration is intrusted to a board of managers, of whom one is a general director and another a vice-director. The scientific work of the Institute is carried on in the two departments of physics and chemistry, each of which has a departmental director and a number of staffs, graded as fellows, associate fellows, and assistants. The departmental directors, who are also fellows, superintend the research work in their own departments, but each fellow is expected to undertake researches on his own account, either by himself or in collaboration with other fellows, associate fellows, or assistants. Some of the associate fellows may also carry on independent work. A greater number of the researches would then be of an individual character, but there would also be several cases in which certain problems selected by the Institute

would be dealt with from all points of view—cases in which a combined effort of a number of fellows and associate fellows, both physicists and chemists, would be required.

It is expected that, in course of time, there would be formed a certain small number of sections in each of the departments of physics and chemistry, with a chief in each section, such, for example, in the chemical department, as the section of inorganic and physical chemistry, and the section of organic and biological chemistry. It is not in contemplation, however, to form separate sections for so-called pure and applied science, still less for such subdivisions as are generally made in applied chemistry, the policy of the Institute being to attack industrial problems from a broader and essentially scientific point of view. In this connexion it may be mentioned that the Institute is expecting a number of special industrial problems to be constantly brought forward for solution by manufacturers, and that the Institute would gladly undertake the investigation of such problems, somewhat on the same lines as are followed at the Mellon Institute in Pittsburgh. Such a policy would, it is believed, not only contribute more directly to the development of special industries, but also bring the Institute into closer touch with the manufacturing world—a state of things which is evidently essential for bringing about a satisfactory federation of science and industry.

The greatest and most fundamental difficulty experienced in Japan is the lack of really capable researchers, and one of the most important objects of the Institute is to train young men in original research. For this purpose a certain number of university graduates are annually elected to research scholarships, which are tenable for two years, preference being always and strictly given to those candidates who have shown signs of originality and development rather than to those who have most distinguished themselves in examinations. During the two years of his term a scholar works at some original research, either in the University or in the Institute, and if, at the expiration of the term, he proves himself to be sufficiently satisfactory, and also desirous of getting a situation in the Institute, then he will be appointed an assistant. If, however, he prefers to go elsewhere, he is quite free to do so. The Institute loses nothing by this, for its object is to train young men in research work, no matter whether they may or may not become members of its staff. An assistant receives further training in the Institute by constantly associating himself with the work of one of the senior members of the staff, and is, on being found to be sufficiently capable, promoted to an associate fellowship, and ultimately to a fellowship, with a proportionately increasing salary. A few of the associate fellows are annually sent abroad for further training, there being three (Asahara, Nishi-Kawa, and Takamine) in the United States at present.

The laboratories and workshops of the Institute will be built upon a site which has been bought in a northern district of Tokyo, not far from the University, but it will be some years before these are completed. Meanwhile the research work of the Institute is being carried on in the Universities of Tokyo, Kyoto, and Sendai, the authorities of these Universities having kindly placed some of their rooms at the disposal of the Institute, and the salaries of those engaged in or assisting research for the Institute, as well as expenses for instruments, chemicals, &c., being borne by the Institute.

It may be added that the reason for making the Institute independent in its organization of either the University or the Government was to enable its staff to devote the whole of its time and energy to research, free from any tutorial work or the drawbacks attending a Government institution.

—*Nature*, 12th December, 1918.

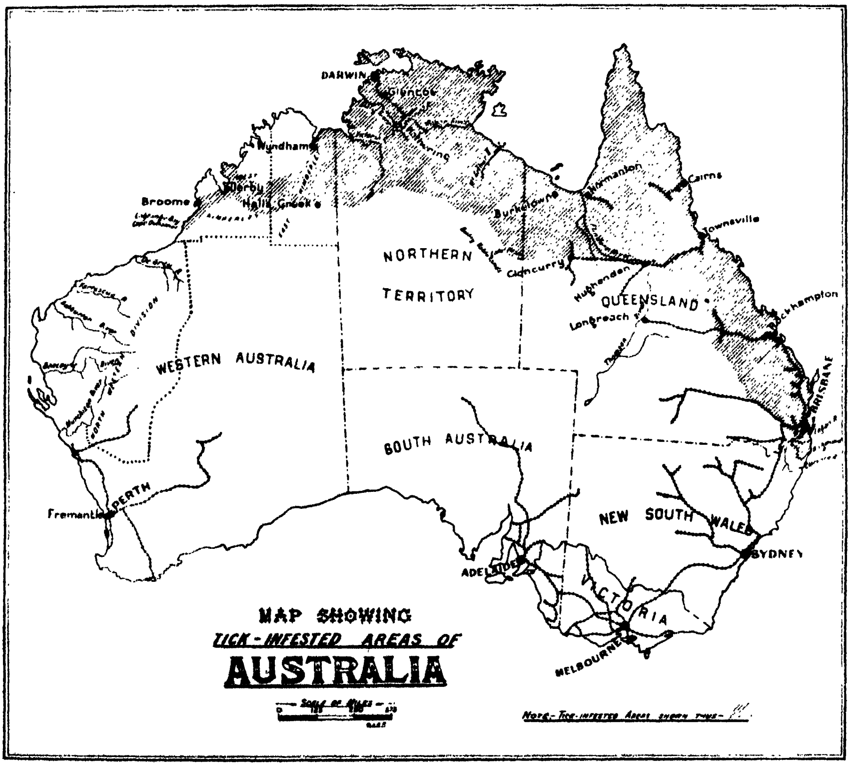
Science is organized knowledge.

—*Herbert Spencer.*

The Cattle Tick Sweeps Onward in Australia and Inflicts Heavy Losses.

IN THE UNITED STATES TICK IS BEING DRIVEN BACK.

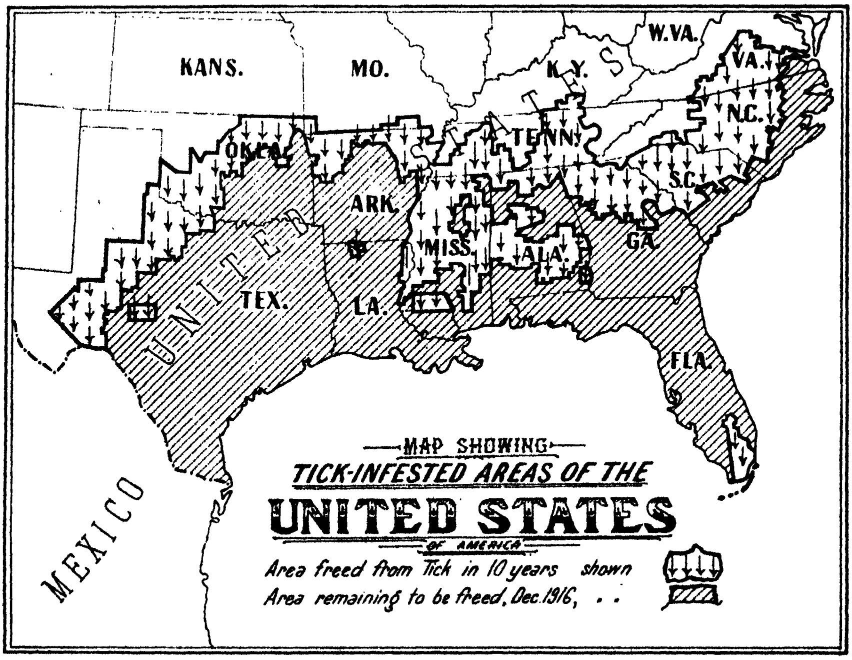
The two maps which are here displayed require little by way of explanation. The lightly-shaded portion of the one indicates the area in the United States infested with the cattle tick, and the darkly-shaded portion of the other shows the area of infestation in Australia. The point of interest which these outlines emphasize is that in the United States the frontier of the cattle enemy is being steadily pushed back, while in Australia it is being steadily pushed forward. Within ten years on the one hand a huge area has been freed from the pest, while on the other huge areas have been infested.



MAP OF TICK-INFESTED AREAS OF AUSTRALIA.

When the cattle tick was introduced into Australia is not definitely known. Attention appears to have been first directed to the existence of the trouble by the mortality that occurred in a mob of cattle (introduced from Queensland) at Glencoe, about 100 miles south-east from Port Darwin, about the year 1880-81. From this centre the tick has evidently spread, until now it has taken possession of the littoral from the Tweed Heads (N.S.W.) to Wyndham (W.A.), and penetrated hundreds of miles inland. Year by year it goes merrily marching on, invading new territory, and inflicting serious losses.

A Committee of experts which, in 1916, inquired into the pest estimated that from tick fever alone Queensland has suffered a monetary loss of at least £7,000,000. From loss of condition, and consequent exposure to infection by other diseases, such as tuberculosis, as well as diminished milk production, the loss has been largely augmented. Approximate figures covering these headings are difficult to arrive at.



MAP OF TICK AREAS OF THE UNITED STATES, SHOWING AMOUNT FREED FROM TICK IN TEN YEARS.

From tick infestation, as distinct from tick fever, large numbers of cattle have also died. There can be no question that the advent of the cattle tick has seriously affected the meat production of the Commonwealth. So long as the pest is allowed to infest cattle and multiply there will be a constant drain on the revenue of the country, amounting to hundreds of thousands of pounds sterling annually.

> ***The future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind.***
>
> —**PROF. JOHN DEWEY.**

Our Native Animals from an Economic Stand-point.

By A. S. Le SOUEF.*

SEEING that great changes are taking place in our native fauna, it is as well to consider its value or otherwise to the country, and, if necessary, to further protect and increase, if possible, the asset it represents.

It may fairly be said that in the next century only animals of absolutely economic value will find room in any country outside of reserves, so rapidly is the unused land of the earth being occupied and turned to commercial use.

VULPINE OPOSSUM. [Photo. by Harry Burnell.

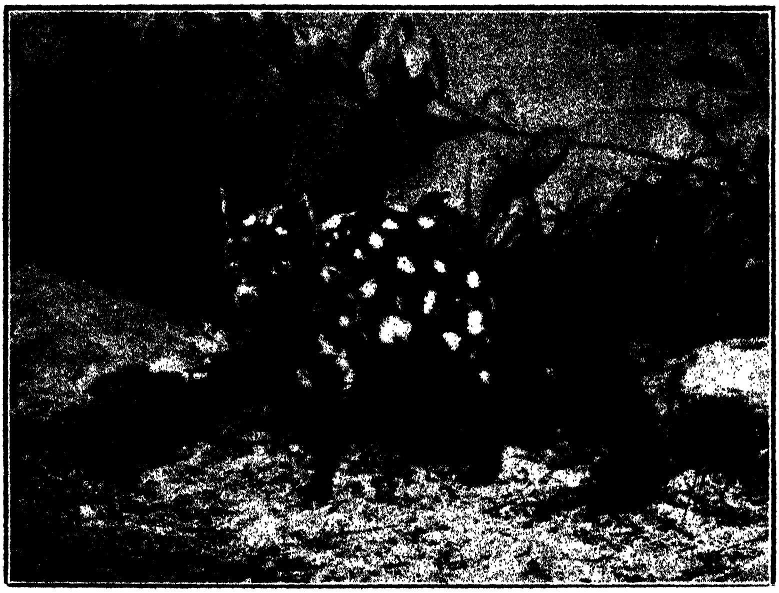
Our native animals have a very distinct commercial value not generally recognised, in that they can thrive in country that will not carry ordinary stock; opossums live in the forests, wallabies in rough scrub lands, and kangaroos, owing to their ability to travel long distances, can pick up a living in country that is of no use to the pastoralists, thus it is possible to make otherwise useless country yield some revenue from their skins and hides.

* Director Taronga Zoological Park, Sydney.

The money that has been made out of our wild animals in the past represents millions of pounds, chiefly from the furred skins of the opossum and wallaby and the hides of the kangaroo, but this trade is being rapidly lost from various causes, some of which can be rectified.

The protection of the animals is a State responsibility, and although there are various Acts with that end in view, there is very inadequate machinery for their administration, and the trade in furs and skins of protected animals is not greatly interfered with, and it is quite possible under the present circumstances that some species will become extinct.

At the present time, practically all the small ground marsupials are being killed off, firstly by settlement, and secondly by the introduced



NATIVE CAT. [Photo. by Harry Burrell.

fox and domestic cat. This principally refers to the rat kangaroo, bandicoot, native cats, and marsupial rats (*Pharscologals*).

There is evidence that the native bear (*Koala*), native cats (*Dasyurus*), and the phascologales disappeared suddenly all over the country, about 1897, from a disease; the former is now only numerous in parts of Queensland and in South-Eastern Victoria, the *Dasyurus viverrinus,* once so plentiful, is now only in evidence in county Cumberland, round Sydney, and the brush-tailed phascologale seems to have gone altogether.

The effect of this, as far as the rat kangaroos are concerned, may not be very great, as they were apparently herbage feeders, but the bandicoots are insectivorous, and live largely on the larva of certain beetles, which, if lacking other enemies, may unduly increase, but the most important phase is that, in the absence of the native cat and the phascologale, the mice will increase unhampered, except for the predatory birds and reptiles, and these proved rather inadequate in the recent visitation.

The koala is purely a tree-feeder, they eat the leaves of *Eucalyptus punctata*, *E. microcorys*, and *E. melliodora*, and *E. gunnii*.

The mountain opossum (*Trichosurus caninus*) is confined to the Dividing Range, and seems to be only found in the mountain ash (*Eucalyptus gigantea*) country—there is a black sub-species found in the coastal scrubs of Northern New South Wales and Southern Queensland whose feeding habits are not known.

The vulpine opossum (*T. vulpecula*), found all over Australia, has many food trees, among which are *Eucalyptus coriacea*, *E. viminalis*. *E. botryodes*, *E. maculata*, *E. piperita*, *and E. sideroxylon*.

STRIPED OPOSSUM.
[*Photo. by Harry Burnell.*

The ring-tailed opossums (*Pseudochirus*) feeds on many scrub trees, including species of eucalyptus, eugenia, personia, acacia, angophora, passiflora, &c.

All the opossums are being rapidly reduced in numbers, and in spite of protection in New South Wales do not seem to be holding their own. They have suffered by the system in vogue, by which when they become numerous in any State the protection was lifted, and every available animal of any age or sex that can be found by the catcher is killed, and the remnant, if any, left to breed up again. The fox has been found to kill them in many districts. Considering their great

commercial value, they are well worth careful study and conservation. They have all the attributes of domestic animals, in that they are quiet, inoffensive, and easily handled. In our forest reservation, other things being equal, their food trees should be grown and shelter provided, for the limit to their numbers, apart from food supply, is hollows or cavities in which to retire into during the day, and if a certain number were taken every year much timbered land would become revenue producing.

Kangaroos are grass-eaters, and, as such, are not of much use on land that can be used for sheep or cattle, but at the present time there are numbers on private properties and Government lands throughout the States. They are protected until numerous, when an open season is declared, and all and sundry killed off. If the land-owner were allowed to kill males of a certain size they would be prevented from becoming a nuisance, and the danger of total extermination eliminated. Kangaroos are fairly numerous in the vast unoccupied lands in the Central and Western districts, where they are kept in check by wild

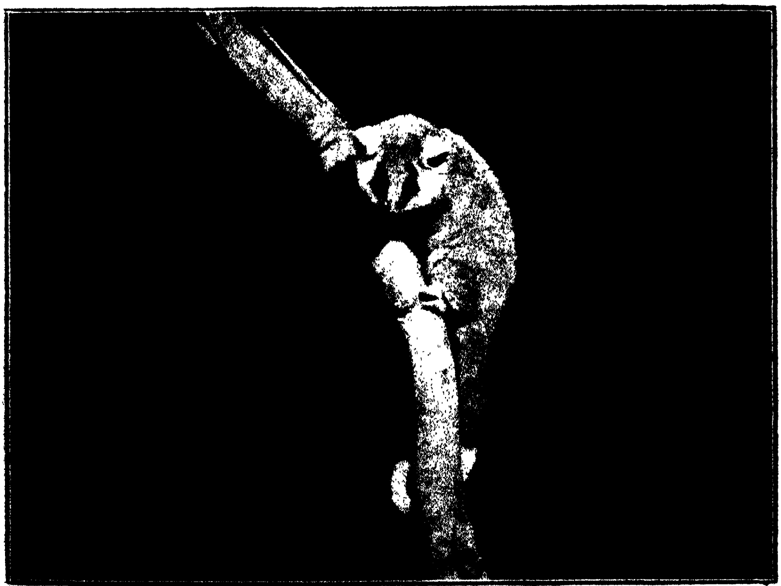
KOOKABURRAS (LAUGHING JACKASSES).

dogs and professional shooters, but in the absence of any supervision it is possible that in times of drought, when they are concentrated on few sources of water supply, they may become extinct.

Wallabies are in a different category, as they generally occupy rough scrub lands, where they are not easy to find, but they will travel long distances for certain foods, and can thus be made to enter enclosures and trapped without injury. The usual method of procuring wallabies is to set traps on their beaten paths in the scrub, or to shoot them.

The immense economic value of our bird fauna is fairly well known, but more exact knowledge of the specific value of certain species is needed, also of bird enemies, and inquiry into the possibility of increasing the number that can live on pastoral and agricultural lands. At present, much is left to chance, and birds that are invaluable are left to

SQUIRREL PHALANGER.



RING-TAILED OPOSSUM. [Photos. by Harry Burnell.

fight their own battles, their nesting sites are destroyed, and poison, either for rabbits or blowflies, decimates them. Definite study into habits and food, the perfecting of other methods of killing vermin than exposed poison, the preservation of nesting sites, and further education as to their value would be equal to giving a very substantial cash bonus to the community in the increased number of feathered assistants that would be available to attack insect pests that beset the primary producers.

There is an evergrowing demand for our parrots, cockatoos, and finches for aviary purposes; these exist in millions throughout the country, and it is probable that this trade could be largely increased without injury to any economic factor, as these families are grain and seed eaters.

Commensurate with its value, our fauna is not receiving intelligent treatment, and it is necessary to carefully study it with a view to organizing its scattered wealth.

"We must rise to this great occasion, turning a frightful calamity into a lasting good. We are beginning late, but we may at least avoid the mistakes of those who blazed the trail. Our duty is clear: our great industries, primary and secondary, must be stimulated, advised and aided by scientific industrial research and by wise laws on a scale commensurate with their national importance and value."

Inaugural Speech—*Right Hon. W. M. HUGHES, P.C., &c.,*
First Chairman of the Advisory Council
of Science and Industry.

Australia Self-Contained.

NEW INDUSTRIES. WAR LESSONS.

By H. W. GEPP.*

(I.)

THE war brought about the ploughing of many new furrows and the uprooting of many old fallacies. Under the impulse of necessity, Australia was forced to rely more and more upon her own resources and to depend more and more upon her own initiative. There is the danger, however, that with a return to normal conditions of trade and industry, the fresh fields which we were opening up may be neglected, and lacking diligent and intelligent cultivation may quickly become choked and overgrown.

We are beginning now, however dimly and imperfectly, to realize that in the new war upon which we are about to enter—a war for economic existence—that we, as a nation, must be self-contained. We must become more self-reliant; we must display keener enterprise. There must in future be no sole dependence upon other countries for the production of essential commodities. Australia must make a stronger effort to produce the finished article from at least a portion of her raw materials, and that effort must be accompanied by efficiency, both national and individual. Undirected and un-co-ordinated striving after vague and indefinite objectives must give way to an organized and sustained attempt to reach a definite goal. National efficiency can effect this change. Individual efficiency will hasten it. An addition of £4,000,000 per annum in taxation to the huge financial burden under which we are struggling renders this effort imperative.

The question then presents itself—what are the difficulties, and how shall we meet and overcome them? As conditions are at present we cannot survey the future without serious misgivings. The old order must be changed for a new.

Australia possesses great natural resources, and all the potentialities for commercial expansion. It produces, or can produce, all necessary foodstuffs. It is pre-eminent in the production of wool. Cotton and flax can be grown in abundance. All the metals—iron, steel, copper, lead, zinc, aluminium, tin, chromium manganese, and nickel—exist in large quantities ready to be utilized. There is ample supply of the rare metals such as tungsten, molybdenum, titanium, osmiridium, and platinum. All the fuel oils—petrol, commercial alcohol, lubricating oils, waxes; all the potash, acetic acid, acetone; and all the sulphur-bearing materials are available for our use.

* General Manager of the Electrolytic Zinc Company of Australasia Proprietary Limited, and a member of the Executive Committee of the Advisory Council of Science and Industry.

Are not these sources of national wealth to be exploited? Are we to depend entirely upon a League of Nations for our future security, and make no effort to help ourselves? From the point of view of defence alone Australia must raise herself to a state of complete preparedness. From the financial stand-point, it will almost certainly be obligatory for us to cease borrowing at the earliest possible moment. This can only be effected by increasing the production and value of our products. Reconversion of all the indebtedness incurred before the war will probably add at least 30 per cent. to the annual interest we shall have to meet. The cost of repatriation—a mere portion of the obligation we are under to our soldiers and their dependants—the cost of pensions, and many other expenses caused by the war, which will be upon us after war is over for several generations, at least, can only be properly met by thorough appreciation of the problem by the whole community. Leaders of the community, both Commonwealth and State, must place the whole position plainly, even harshly, before the people, and organize the country to meet, contend with, and overcome the difficulties which will confront us all.

There are many angles from which this great question can be viewed. One of them, not indeed the least, is the problem of the successful inauguration and operation of new industries which will very materially assist in keeping the people of the country effectively employed, and will enormously increase the value of the natural products of Australia, and make all the difference from the points of view of defence, repatriation, population, and finance.

If the destinies of this country are to remain in the hands of the people of Australia, if we wish to pass on to our children a country of which they and we may well be proud, then surely we must begin to work much harder towards setting our whole house in order. It is therefore absolutely imperative for new industries to be started in many quarters to work up primary products and by-products, and, further, it is equally essential for the Governments of the Commonwealth and States to assiduously and persistently foster these new industries.

The Commonwealth already has shown its intentions in the formation of the Institute of Science and Industry, and the Board of Trade, and at least one State, South Australia, had previously taken steps in the same direction. More, however, is necessary than the formation and financing of Institutes and Boards, namely, that the efforts should have the heartiest support from all departments of the different Governments, and from the whole of the people in the Commonwealth. Much propaganda work in this direction is still needed. Salaries commensurate with the proposals should be paid, and information and assistance from other countries, particularly Great Britain and the United States of America, should be obtained in starting these new organizations aright. Indeed, if it were possible to obtain from the United States Government one of their principal officials from, say one of their most successful Bureaux, such as the Bureau of Standards, either temporarily or permanently, it is more than likely much time, labour, and worry would be saved. All will certainly admit that any available experience should be obtained without, of course, casting the slightest reflection upon the ability of our own officials.

Assuming that individualism in detail is more suited to the Anglo-Saxon temperament than collectivism, we shall have to consider how a

big initial programme of new industries can be carried out to insure the well-being of the Commonwealth. The uttermost self-sacrifice has been displayed by our soldiers, and it is incumbent both upon those who have been unable to get near the fighting line, also upon the younger generation growing up, to assist to the utmost in dealing with the aftermath of this war tragedy, and to sacrifice ourselves to whatever extent is necessary towards building up the Commonwealth of the future on the best lines for the final realization of the Great State wherein the happiness of all its members is the chief object and aim.

We have problems, indeed many problems, in front of us. Many men have already returned, and a far greater number are still to return. They are *not* the same men as they were when they went away. They have been through experiences, compared with which our greatest trials are as *nothing;* they come back bigger, broader men, capable of bigger, broader things; more capable for better or for worse than they were when they left us. They are, in many cases, not normal when they return, and it is one of our highest duties to show them we are doing our best to appreciate, and are prepared to sacrifice ourselves to carry out, towards building up the future, what their supreme efforts have helped to make possible.

What are the essential factors operating towards the successful development of new industries in a young country?

They may be divided under several headings, viz.:—

1. Natural Resources.
2. Politics.
3. Finance.
4. Education.
5. Organization.
6. Relations between Labour, Management and Capital.
7. Relations between Different Operating Companies.
8. National Efficiency, in its broadest sense, for the attainment of which health and contentment are essential.
9. Maintenance of the Ethical as opposed to the Materialistic Attitude of Mind.
10. Development of the Spirit of Industrial Citizenship.
11. Recognition by the Country of the Value of big Companies or Corporations when properly controlled.

Natural Resources.—As shown previously, the natural resources of Australia are immense, and, in many cases, almost untouched. For instance, we only handle a small proportion of the wool we produce; we have no manufactures of cotton goods at all in the country, and still export a very large quantity of ores and concentrates without abstracting the metal therefrom. We export sulphur-bearing concentrates and import sulphur-bearing materials. We export wool and import tweeds, and the history of the treatment of by-products in Australia has yet to be started. As an example of the wastage that is going on, there is one public abattoir killing all the meat for many thousands of people, where every drop of blood is run to waste daily, and this is but the merest instance.

Politics.—The present and future positions call for statesmanship of the highest order. The United States Government has definitely adopted the practice of calling together bodies of specialists to consider

and recommend upon specific problems and, in almost all cases, such recommendations have ultimately been adopted.

Whatever system is to be followed finally in fostering new industries, it seems desirable for our Commonwealth Authorities to have a full review of future necessities, and our statesmen and leaders to consider the position closely. Some favour a system of bonuses on production from new industries, graduated according to a logical scale based upon the essential nature of the industry to the Commonwealth, and the particular circumstances of each case.

Further, there is the whole problem of the heavy cost of building and plant construction here in Australia; the question of heavy duties upon machinery, &c., absolutely unobtainable in this country.

The question of markets is already under investigation by the Commonwealth. In this connexion, the appointment of Mr. H. Y. Braddon to Washington was a most excellent one from all points of view.

For some time past, the United States Ministry of Commerce has been sending specially selected technical men touring the world to report on their particular subject, for the benefit of manufacturers in America. This system might well be considered by the Commonwealth authorities.

Finance.—This subject calls for very special consideration by experts with a view to the possible formation of trade banks, supported or guaranteed by the Commonwealth for the purpose of supporting industries favorably reported on by selected experts.

Education.—Either there is a sad lack of appreciation or a very serious state of inertia with regard to the matter of education. We progress up to a certain point, we deal fairly thoroughly with primary education, then all appreciation of the issues involved and the purposes of education seem to be lost entirely, with the result that the final position is most unsatisfactory and indefinite. There is an imperative call for a broader outlook, for the expenditure of much more money, and for thorough appreciation of the fact that, unless all steps are taken to discover, develop, and completely educate the best brains growing up in the community—irrespective of which particular class of society they exist in—the country cannot be expected to advance as it should in properly co-ordinated and balanced prosperity.

We allot a student of special ability £40 per annum as a scholarship, out of which he is expected to attend the University, keep himself, and, possibly, also assist in keeping the home going, with the result that many of the best men are unable to avail themselves of the opportunity, and the country loses much more than the man. Obviously, if it should pay to send the man to the University, it pays to enable him to live decently, without worrying about ways and means, and, moreover, arrangements should be made that each of these men has a post reserved for him when he completes his training course. In this connexion, large companies can clearly do much more than a number of smaller ones, as they have more reserves, and can afford to carry larger overhead expenses.

The experience of the world generally is that men of directive capacity and imagination, who are at the same time well-balanced, are very scarce. They do not originate from any one particular class of society, and it is one of the most important duties of education to discover such men and make them realize they are given their particular ability and balance in trust for society. They should be encouraged

and developed that they may become the leaders of industry, for without them any country is poor indeed.

Initiative, imagination, energy, and organizing ability have always been scarce, and are much scarcer to-day in this country owing to so large a proportion of the younger men of the best type having been lost to us through the war. One of the greatest necessities of the present is to appropriate the next crop that is coming along and develop it to the utmost. Supposing one were asked to recommend a dozen men for big jobs of a developmental kind, could we do so?

Australians are themselves, or are descended from, people who have shown much initiative by coming so far from the Home Land, and our soldiers have made it abundantly clear what initiative really means. Hence Australia possesses probably as large a percentage of initiative as any other country.

It is the country's duty to stimulate this quality and afford it opportunities for development.

Organization.—Firstly, organization by Commonwealth and State, in connexion with legitimate fostering of industries from the points of view of technique and markets; and, secondly, organization of industries from aspect of internal details.

Regarding the first, it should be thorough, and with the whole power of the people behind it should be consistent with the great objects to be achieved.

In dealing with the problems of inauguration and organizing new industries, it is essential that those responsible should have the subject examined from all angles, and prepare a report and estimate covering the whole economics of the proposition. This will, of course, include the cost of production, the price and quantity of the raw materials available, the question of the supply and efficiency of labour, and the organization required to insure the maintenance of reasonable contentment and consequent efficiency, the matter of freights, and the whole broad subject of available markets. When all this has been thoroughly sifted and thrashed out, further details of finance have to be carefully examined, and ample provision made for necessary capital, both for the construction and operating, including what is very often overlooked or underestimated, viz., capital required to conduct the business. This latter item is often much larger than anticipated, but, of course, is subject to interest, not to depreciation charges.

Engagement of a large staff requires considerable experience, and special consideration must be given to the temperament of each member of the staff, also to remember that, however good a man may be at his special work, he is no use to the whole job unless he will become a member of the team.

Another task is to programme all proposals and lay out, as far as possible, a table of precedence in construction and operating, so that all the staff shall clearly understand in what order the work is to be undertaken.

All necessary attention should be paid to research work, and a special department allocated thereto, which must conduct investigations in consultation with the chief operating men in so far as the research is related to the operating.

(*To be continued.*)

A Forest Policy for Australia.

By C. E. LANE-POOLE.*

(*Continued from page 93.*)

AUSTRALIA has suffered greatly through her isolation. Canada naturally followed in the footsteps of America. She drew on the forestry schools of Yale and Harvard for her skilled men, and her people quickly developed a forest conscience. Australia has no such near neighbour—New Zealand being, if possible, a worse offender than herself—and she has had till recently no forest school in which to train her foresters. It is little wonder, therefore, that the country as a whole has not yet realized the seriousness of the situation. Already we rely on an importation of close on £3,000,000 of lumber a year, a figure which, for our small population and the infancy of the country, is a startling one. We find that our tanners cannot satisfy their needs from local supplies, but must rely on Natal for their wattle bark, bark obtained from trees grown under cultivation from seed imported originally from Australia. Our coachbuilders must look to America for their hubs, spokes, and shafts. The total area of Australia is 1,904,000,000 acres, and of this the forest area, according to the statistics, is 102,000,000 acres, or 5 per cent. But this area arrived at by the statistician is not the area of timber country, but the area on which trees, be they mulga, mallee, or other scrub, are growing. The actual area of forest country, that is, country covered by timber for milling purposes, or capable of growing such timber, was set down at the Inter-State Forestry Conference held in Perth in 1917, at 24 000,000 acres. This estimates excludes, of course, agricultural land on which timber may be growing. Such land cannot come into the forest estate. The percentage of forest in the Commonwealth is, therefore, 1 per cent., a percentage which all will readily admit is utterly inadequate for the needs of the population which the country will support in the future. It was Evelyn who wrote in 1664*:—

> Since it is certain and demonstrable that all arts and artisans whatsoever must fail and cease if there were no timber and wood in a nation (for he that shall take his pen and begin to set down what art, mystery or trade, belonging any way to human life, could be maintained and exercised without wood, will quickly find that I speak no paradox), I say when this shall be well considered, it will appear that we had better be without gold than without timber.

If the Commonwealth is to attain her full development, then it is essential that she should take every step possible towards improving her forest asset, so that she may draw from it in the future a maximum output of timber to serve the many industries to which wood is the essential key.

The situation has caused many thinking men to issue notes of warning. The Inter-State Commission on Timber, after an exhaustive research into the timber resources of all the States, commented on the alarming situation in very plain terms†:—

> Our timber industry presents features of exceptionally grave importance from an industrial point of view. The national aspect of the question hitherto has received but scant attention, notwithstanding the fact that, in the absence of immediate provision for afforestation and re-afforestation, the industry in respect of Australian timbers is, within a brief period of time, practically doomed to extinction.
>
> Excepting perhaps the State of Western Australia, it is highly probable that within a period of thirty years, at the present rate of consumption, we shall, for all practical purposes, exhaust our accessible marketable supplies of all the more valuable timbers; and from the present outlook it is not unreasonable to anticipate a later period, when Australia will depend upon other countries for her supplies of eucalypt hardwoods.
>
> Our policy hitherto appears to have been based upon the assumption that our timber resources are inexhaustible. It cannot be too strongly emphasized that, although we have magnificent timbers, which in beauty and utility for many industrial requirements are unexcelled, the forests upon which we may rely for these timbers are comparatively very limited in area. They are scattered for the most part in isolated localities, on the ranges adjacent to the coast.

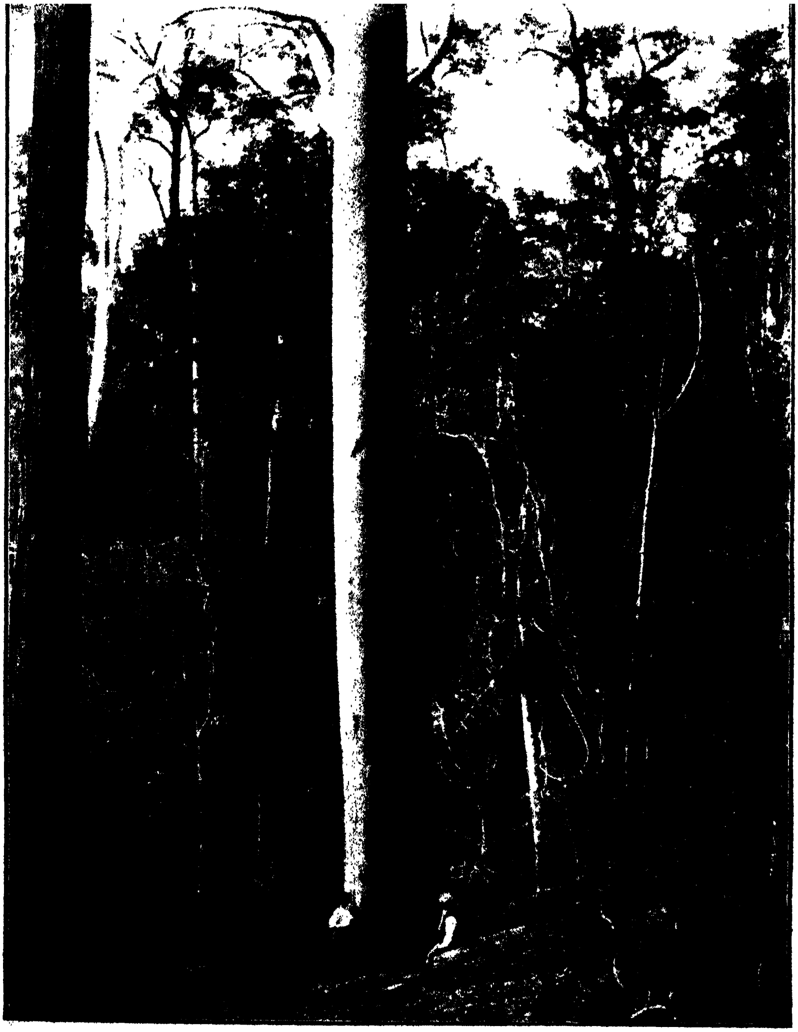
Mr. Hutchins, whose wide knowledge of forestry in the Dominions gives special value to his criticism of Australian forestry, places the cost of the last 100 years of bad forestry at the enormous figure of £588,500,000.‡ The expert foresters,

*Evelyn's "Sylva," 1664.

†Report of the Inter-State Commission, Tariff Investigation. Timber, 9th May, 1916.

‡"Australian Forestry." D. E. Hutchins.

heads of the Departments in each State, when in conference, have shown the seriousness of the situation, and repeatedly brought their resolutions before various Governments. On the last occasion, the subject was laid before the Premiers' Conference. What is now needed is a forest policy for Australia as a whole, a definite line of action which will be recognised by all Governments as being essential to the general welfare of the Commonwealth.



BLUE GUM (EUCALYPTUS SALIGNA) GOSFORD DISTRICT, NEW SOUTH WALES.

In the first place, a thorough stock-taking of the land is needed. The land should be classified according to its possibilities of development, and all land unfit for agricultural purposes should be examined with a view to determining its capabilities for growing timber. If forest is already growing on the land, then the classification should show clearly the boundaries of the portions that may be put to agricultural use after the timber has been utilized, and land which it will not pay to clear for such a purpose. Here there may be a clashing of interests,

but it should be possible for experts to lay down some criterion. In the Philippines, the criterion is whether the land with the timber on it will fetch a higher price than the land after the mill logs have been removed to the mill.

The next step is the demarcation of all forest land by survey, and, following on the demarcation, comes the permanent reservation of the land as State Forest. Such reservation must be of a character that will make it exceedingly difficult for

TREE FELLING, HUON, TASMANIA. Peppermint Trees: "Eucalyptus Amygdalina," of Tasmania, are admitted to be the tallest trees in the world.

a revocation to be obtained. Land suitable only for forestry and dedicated to this purpose should be inalienable.

Having established the forest estate on a permanent basis, then the question of its management must be envisaged. There will be large areas of destroyed forest, small areas of partially destroyed forest, still smaller areas of milling country, and, lastly, areas of barren country suitable for afforestation. All these

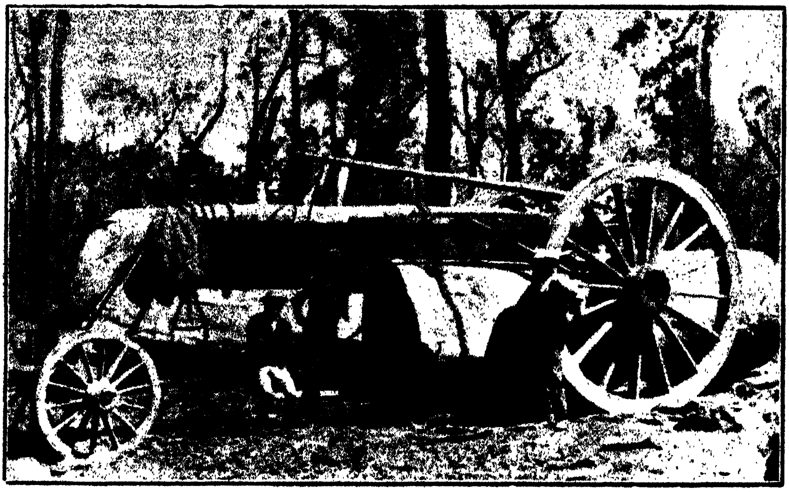
types of land that go to make up the forest estate must be taken in hand without loss of time. The destroyed forests require a scheme of reforestation, the partially-denuded areas one of utilization and reforestation, the milling country must be worked on lines which will assure a permanent yield, however small, from these poor remnants of our forest wealth. Lastly, the barren lands must form the subject of an exhaustive inquiry and of careful experiment, with a view to discovering the best species, indigenous or exotic, to be used for afforestation in each locality. All these schemes should be incorporated in what are technically termed forest working plans. These working plans are the forester's bible; in these is set out for a long period ahead the whole of the scheme, the compartments that are to be dealt with each year, the nature of the work, the cost, in fact, every detail necessary to enable the officer in charge to carry the operations through on lines which assure a continuity of policy. In forestry, more than in any other industry, a continuity of policy is essential. The comments of the Committee reporting on forestry in England are worthy of note in this regard:—*

Further, the afforestation policy of the State, once embarked upon, should be as little as possible liable to be disturbed by political changes or moulded by political pressure. We cannot, and do not, claim that it should be independent of parliamentary control, but when Parliament has once adopted a policy of afforestation, the decisions that have to be taken as that policy develops should not be taken by politicians, and if grievances and difficulties arise they should be adjusted in an atmosphere in which forest policy, and not political expediency, is the deciding factor. The last respect in which independence is important is with regard to funds. An element of control is, of course, essential, and it may well be strictly enforced. Parliament must be informed of the cost and result of each year's work. The public, in fact, will want to know, and will have a right to know, that they are likely to get value for their money. This, however, ought not to be incompatible with an arrangement under which the authority will have, during its early years at any rate, a greater degree of certainty as to the funds which it will administer than is generally produced under the system of submitting annual votes to Parliament. If there were a power to pull up the authority by the roots to see how it was getting on, the results might be almost as serious as if a similar process were performed upon the trees that it had planted. The authority, like the trees, must have a chance of striking deep root, and must, therefore, be able to plan its work for some years ahead with the certainty that it will have funds to carry it out.

The drawing up of the forest working plans demands the skill of expert foresters, and it will be therefore necessary to obtain the services of a number of technically qualified and fully trained foresters. Unfortunately, the number of expert foresters in Australia to-day is so small that they can be counted on the fingers of one hand. Also the facilities for training foresters in Australia are not good. There is a lack of demonstration areas, model forests, where the student can learn how an area of timber should be managed. The theoretical training is given at Adelaide University. South Australia, owing to its climate, is particularly unhappily situated, so far as forests are concerned, and the students, while excellently grounded in the theory, lack that practical experience which can only be obtained in a forest under sound sylvicultural management. It will be necessary, therefore, to begin with, to import a small number of highly-trained and experienced foresters as working plans officers. Then, in order to build up the trained staffs to deal with the forests under plans laid down, it will be necessary to establish a school of forestry for the whole Commonwealth. There are indications at present that several of the States contemplate establishing forestry schools. A duplication of such institutions is the mistake that England and the United States of America have made, and which they deplore to-day. France has one forestry school, from which she turns out sixteen students annually. The school is situated at Nancy, in the forest country, and it boasts a staff of eight professors. It is unattached to any University, and supplies the whole needs of the French Forest Service. The duplication of schools in Australia would result in four or five third-rate schools, mere lectureships attached to Universities, while what is required is one first-rate school. As to the site for such an institution, I do not think that there can be any doubt among foresters as to the State which would afford the largest range of forest conditions for the education of the student. That State is New South Wales, where the forests range from the edaphic formations on the Murray to the red mountain ash near the snow line; from the brush forests of the northern rivers, through the more open eucalypt ironbarks, &c., to the cypress pine on the sands

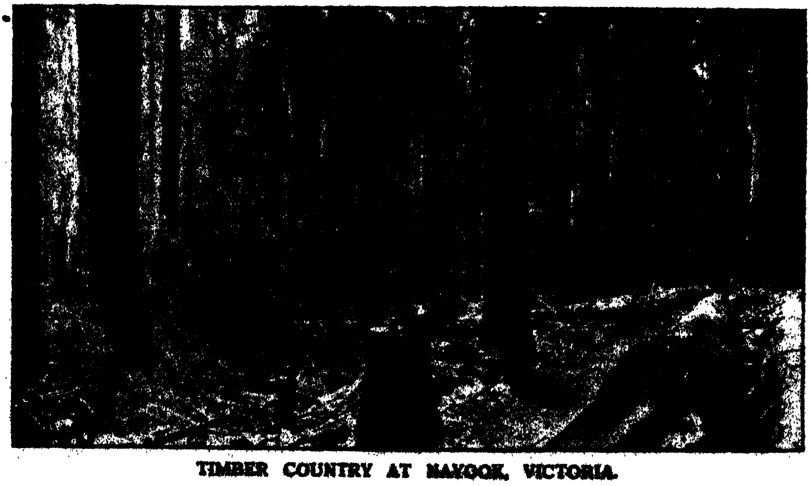
*Final Report, Forestry Sub-Committee, Reconstruction Committee, pages 62-63.

of the interior. Such a range of forest conditions would enable a student to acquire knowledge which would equip him for service in any forests in Australia. The New South Wales authorities have chosen a site for a school near Gosford, and are now seeking a principal and staff. It is to be hoped that the school will be soon an established fact, and that it will be on such broad lines that it will



LOG-HAULING WHIM, WESTERN AUSTRALIA.

become the school for the whole Commonwealth. With the working plans officers to lay down the plans of the management of the State forests, and the Australian-trained staff of district officers to supervise the carrying out of the plans, the foundations of the professional staff will be well laid.



TIMBER COUNTRY AT NAYOOK, VICTORIA.

The next requirement will be a trained subordinate staff of foresters. These men will be the N.C.O.'s of the forest army, and it is essential that they also should receive a thorough practical training, though it is not necessary for them to reach the high degree of education and theoretical training that the professional foresters attain. It is possible that a system of apprenticeship, combined with instruction given in camps from time to time by a peripatetic lecturer, would give good results. The forester's duties should consist of looking after the gangs of

men engaged on sylvicultural work in the forests; he will supervise the felling and sawing of timber on milling permits, the sowing of seed and raising of plants, and the planting of barren land. Under the district officer, he should be respon-

A RAKE OF TRUCKS LOADED WITH KARRI LOGS.

sible for all the work on a given "working circle," or subdivision of a State forest. With this staff and the necessary labour, the carrying out of the working plans may be undertaken.

HAULING LOGS TO MILL ALONG BUSH TRAM LINE, WESTERN AUSTRALIA.

During the growth and progress of forestry in the Commonwealth there will be a continual demand for research work. The working plans officers will be faced with many sylvicultural problems which require patient study by specialists to solve. There will be numerous fungoid and insect diseases requiring investigation. Research into the question of forests and water supply; also into forest meteorology in general will be necessary. All these researches should be carried out at an institution, preferably at the School of Forestry, where, if possible, the staff of professors should be chosen with a view to their taking up this work as well as the principal duties of teaching. Again, there are the problems connected with our major and minor products, which are crying out for solution. Investigations into our gums, resins, kinos, fibres, tanbarks, oils, scents. The physical properties of the timbers must be exhaustively tested; also their durability. The rapid seasoning or kiln-drying of our timbers needs scientific investigation. With the diminution of timber supply the use of inferior woods for such degraded uses as sleepers, paving blocks, poles, and piles is indicated, and here research work is required, with a view to determining the best antiseptic system of impregnation to be adopted. Paper-pulp is another matter which Australia must take in hand seriously. The day is not far distant when the paper-pulp supplies of America

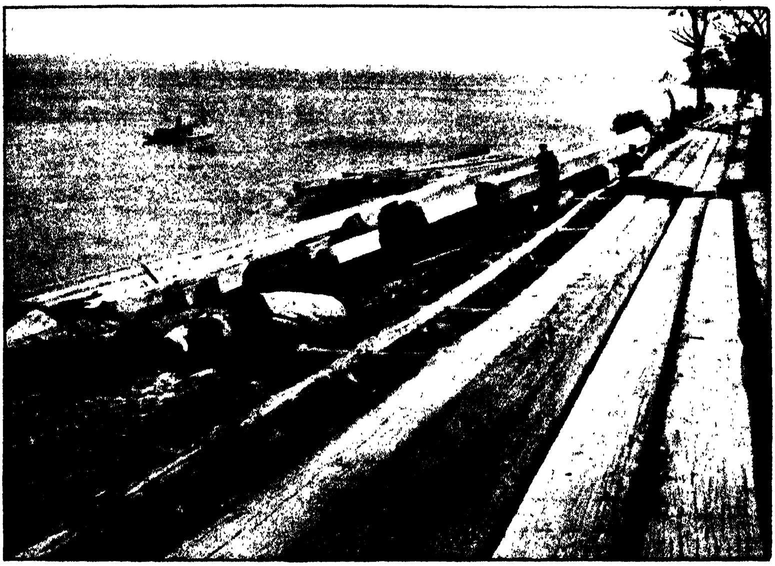
MURRAY RED-GUM FOREST (E. ROSTRATA) AS THE FORESTERS HAVE MADE IT.

will be so diminished that the price of pulp or paper will make it possible for some of our woods, grasses, or sedges to be put to this use. Destructive distillation of wood, and the utilization of wood waste for the manufacture of various products, are two large pieces of research. All these inquiries should be carried out at a properly-equipped Forest Products Laboratory. Such an institution should be quite separate from the Forest School, and, indeed, might very well be established in whichever State has the largest wealth of unexplored forest products.

A very important part of the policy should be forest propaganda. The great mass of the people have but a hazy idea of the meaning of the word "forestry," while the objects which are to be attained under a forest policy are closed books to them. At present the Australian Forest League, branches of which exist in each State, has two publications—*The Gum Tree* in Victoria, and *Jarrah*, in Western Australia. Both are doing excellent work, and it is to be hoped that they will continue and obtain an increased circulation. Journals such as these might well be subsidized, so as to enable them to be published for more general distribution. At present they are dependent for the funds to defray the cost of printing on subscriptions from members and what can be obtained for advertisement space.

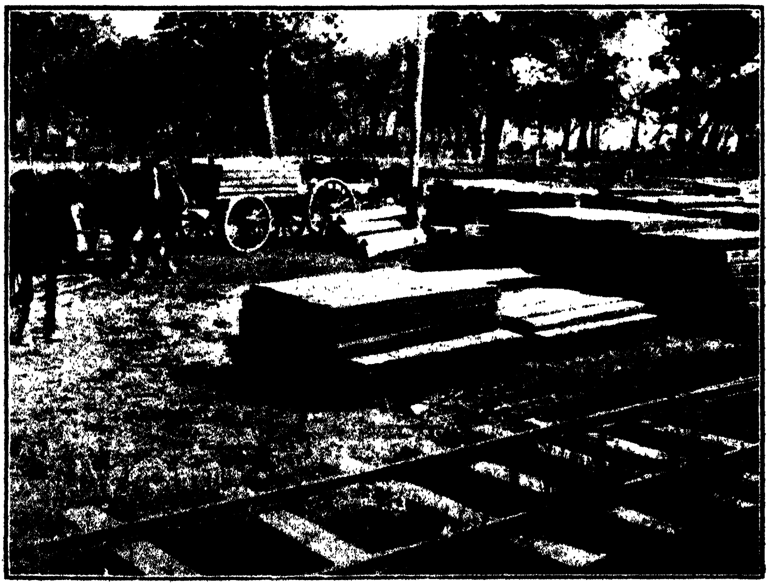
A FOREST POLICY FOR AUSTRALIA.

In New South Wales there is a journal issued by the Forestry Commission, which is entitled the *Australian Forestry Journal.* The Commission is to be congratulated on having embarked on this form of propaganda. The journal is well got



BLUE-GUM PILES AT NORFOLK BAY, TASMANIA, READY FOR THE ADMIRALTY.

up, and it contains contributions from all parts of the Commonwealth, and so has a fairly large circulation outside New South Wales. The development of forest propaganda work is of the utmost importance, and the number of forestry



STACK OF HEWN SLEEPERS, WESTERN AUSTRALIA.

journals should be increased. The Canadian system of lecturing tours through the timber country is a good one, and might well be introduced into Australia. Books on forestry for children are also valuable aids. The older generations are, for the most part, so much in a groove that it will be difficult to impress the altered conditions on their minds. In the matter of fires, the hope lies in propaganda work with the rising generation.

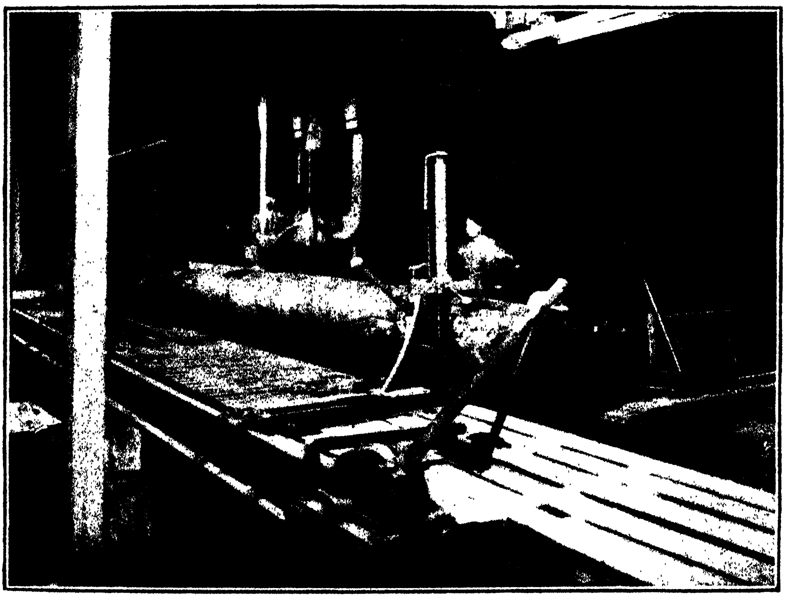
The above, then, are the main points of a forest policy for the Commonwealth. It is obvious that this is merely a skeleton, and it will be necessary for the forest experts of the various States to supply the flesh to cover it and the blood to give it vitality. Only the man on the spot, possessed of a knowledge of the many different local conditions that affect the problem in each district of his State, is in a position to advise on the details of such a policy. There is no doubt, however, that if all the States were to accept some definite foundation of a forest policy, the erection thereon of the edifice of sound forestry would be but a comparatively simple matter. The main obstacle, as has been mentioned already, is the difficulty of finance. The ever-pressing cry of an insistent Democracy for the expenditure of money on purely present and very local problems must of necessity be heard before the voice of the forester. Forestry, while showing a sound business profit, only does so after what is regarded in these days as a considerable lapse of time. The "local member" is far more concerned with the repair of the village pump than the possibilities of his district 25 years hence. He is apt to retort, when the matter is pressed before his notice, with the question, "What has posterity done for me?" Even in the old countries we see that such essential matters as naval defence have been starved of money. In France the outcry for social reforms resulted in the army itself suffering through lack of funds. It is little wonder, therefore, that young nations sparsely populated, and utterly dependent on Government development work for the opening up of the country for settlement, should, even when they admit the necessity of a forest policy, find it impossible to provide the necessary money to finance the scheme.

It is doubtful whether any national work yields as sure a return as forestry, yet it is work in which the present generation, and the voter who governs the destiny of the country, sees no return to himself. Sir Alexander Peacock put the matter as succinctly as possible when addressing the delegates of the Inter-State Forest Conference in Adelaide in 1916. He said: "The trouble about forestry is that the trees have no votes." It is true that certain States have taken steps to provide funds for forestry. New South Wales has ear-marked, under her Forests Act, half the revenue derived from the forests. Victoria has made a permanent annual appropriation under her Act of 1918. Western Australia has created a fund into which three-fifths of the net revenue derived from royalties, leases, licences, and timber dues generally is paid, and which can only be expended for forestry work. These are all steps in the right direction, which will doubtless result in much good work being started; but we have to look forward many years in forestry matters, and the time that concerns the foresters most is when the last big mill has closed down in Western Australia and in Tasmania, when the demand to open up and cut out the out-back forests in Victoria has been acceded to, and the period is reached when there is nothing to look forward to but a long sequence of—from a revenue stand-point—blank years while the forests are being restored once more. The well-populated and more highly-developed States will probably be able to carry on by supplying funds from general revenue, but the less developed States will be unable or unwilling to face the burden, and the forest policy will be relegated to the background. It is this very serious probability that makes the problem of Australian forestry one which should receive the thought of all statesmen to-day. Some plan must be evolved which will meet the situation. If the Central Federal Authority were to adopt a forest policy, and assist those States which are so placed financially as to make forestry a difficult matter, a way might be found out of the difficulty. The forests of the Commonwealth are obviously the heritage of the whole continent, and not of any particular State. The advance of money by the Federal Government to those State Governments which are unable to foot their own forest bills would seem to be sound policy. The investment is a particularly safe one, for the interest and profit on the undertaking are assured, while the security is excellent, being the growing forests themselves.

A FOREST POLICY FOR AUSTRALIA.

In this article I have attempted to sketch what has led up to the serious forestry situation we are face to face with, and, at the same time, to suggest the remedy. Australia has a maximum of legislative enactments and regulations governing her forests, a minimum of forests, and the amount of sylvicultural work she has done is so small as to excite laughter in other lands where forestry is an accepted national policy. The remedy is the adoption of a forest policy throughout the whole of Australia, such a policy to include:—

1. The classification of the land with a view to the demarkation and survey of the forest estate.
2. The permanent reservation of this estate.
3. The appointment of a certain number of highly-trained working plans officers to draw up the plans necessary for the management of the forests.



BREAKING DOWN A WANDOO LOG WITH A BAND-SAW.

4. The establishment of one sound forest school for the training of the professional staff.
5. The training of a subordinate staff in the practice of forestry.
6. The establishment of a Forest Research Institute attached to the Forestry School.
7. The establishment of one or more Forest Products Laboratories to investigate the commercial possibilities of our wealth of forest produce.
8. The initiation of a wide publicity campaign in order to awake a forest conscience in the minds of the people.

Tempering Droughts: Fodder for Lambing Ewes and Lambs.

A letter, dated 1st October, 1918, was received from the Secretary of the Graziers' Association of New South Wales, stating that the Council of the Association had expressed a wish that the Institute of Science and Industry would undertake research in stock diseases, particularly the stock disease which is causing heavy losses in the southern parts of New South Wales. The Secretary of the Association forwarded an extract of a letter from a member of the Association, urging that the Federal Government should undertake an investigation into the question of finding a fodder which will take the place of green feed for lambing ewes. The writer of the letter pointed out—

(*a*) That, owing to dry spells during lambing time, the average lambing from ewes put once to the ram for the year is very low, about 50 per cent. If the lambings can be increased to, say, 80 per cent., there would be a large increase in the number of sheep, in the wool clip, and in the quantity of meat available.

(*b*) Grown sheep can be saved during droughts, there being suitable fodders available.

(*c*) There is nothing at present available that will save young lambs except green food.

(*d*) The fodder required must be one which will make milk in ewes, and at same time be easily digested by lambs.

(*e*) He suggests that a suitable fodder-cake should be devised.

The Council of the Association hoped that the Institute of Science and Industry would make investigations into the matter in view of its great importance.

As a preliminary step, letters asking for their views on the matter and for information as to the lines on which experiments might be conducted were sent to the following:—Professors Watt, D. Stewart, and Paterson, and Mr. A. E. Richardson.

The replies received are summarized as follows:—

Professors Watt and D. Stewart sent a joint rely, stating—

(*a*) That the investigation might quite well be carried out by the State Departments of Agriculture, which have all facilities available.

(*b*) The New South Wales Department of Agriculture has already carried out experiments with regard to supplementing the silage rations for ewes and lambs. (Particulars of these experiments have since been obtained from the Department, and are referred to below.)

(*c*) The main difference between the requirements of mature stock and lambs or milking ewes is that for the latter a succulent food is required, and the most promising basis of a suitable drought ration for them is properly prepared silage.

Professor Paterson pointed out—

(*a*) That ewes with lambs want a less heating ration than mature stock; one that is more digestible and more nitrogenous in amide nitrogen.

(*b*) The desired qualities are found in immature forage, roots, silage, and brewery by-products. Roots, mangels, and turnips are excellent, but too costly. Silage, judging from its utility in dairies, should give milk to ewes, but may possibly hurt young lambs, if allowed to eat it, owing to high acid contents and various decomposition products. The best stand-by would be lucerne or wheaten hay cut at an immature stage, fed chaffed in troughs in a dry condition, or moistened with water and treacle. Lucerne meal ground and pressed into cakes does not seem to offer any special advantage to justify its high cost.

(*c*) Professor Paterson outlines a scheme of experimental work. A number of 1-acre plots could be fenced off with netting on a bare paddock, and 20 ewes with lambs placed in each. Provide water and 1½ to 2 lbs.

dry rations per sheep per day. He suggests a series of ten different rations, consisting of immature lucerne hay, immature wheaten hay, both by themselves, and in combination with treacle, oats, linseed cake, dried brewers' grain, and silage, also silage alone, and with maize and peas. At the conclusion of the experiments the results would be judged by numbers, appearance, and average live-weights of lambs reared.

Mr. A. E. V. Richardson stated—

(*a*) The difficulties in evolving a cake for the purposes proposed are –

(1) to make the cake at a reasonable cost; and

(2) to get graziers to use it.

(*b*) If graziers would lay in a reserve of feed, either as grass hay or silage, the loss of both sheep and lambs in drought would be largely eliminated.

(*c*) Molasses, in conjunction with ordinary stock foods, would greatly assist in saving lambs in times of drought. Lucerne chaff damped with molasses makes a specially good ration for lambs.

(*d*) The Queensland Molasses Co. makes a product called "Molerne" from molasses and lucerne, and sells it at £1 higher than the market price of lucerne. An analysis of it has been made by the Agricultural Chemist, and it forms a cheap and valuable food for young lambs.

(*e*) While the production of new types of stock feed is important, and worthy of investigation by the permanent Institute, he would prefer to encourage propaganda work in forage conservation.

New South Wales Department of Agriculture forwarded an extract from the New South Wales *Agricultural Gazette* of June, 1914, giving particulars of different methods of feeding lambing ewes. The experiments were initiated to investigate the question of food supply under normal conditions in cross-breeding for wool and mutton, but owing to shortage of rain and natural feed it was necessary, shortly before the ewes were due to lamb, to resort to hand-feeding.

(*a*) During the earlier periods of the hand-feeding the ewes were fed on ensilage from barley-grass, lucerne, and other herbage, chiefly trefoil (cut when barley-grass was green and in ear). The allowance was 6½ lbs. per day per sheep. Though the ensilage had been in the pits several years, it was quite succulent and palatable. The only objection found was that, if not readily eaten by the sheep, and left exposed, the heads of the barley-grass turned dry.

(*b*) During the latter periods three methods of feeding were adopted, the sheep being classified into (i) British breeds; (ii) Cross-breds; and (iii) Merinos. The rations consisted of two or more of the following:—Chaff, piemelon, silage, and wheat.

(*c*) No comparative results are given of the different methods of feeding. It is stated that, though some of the ewes were somewhat low in condition at the time of lambing, they remained vigorous, and continued to rear their lambs. Fourteen of the ewes died, but most of these were the result of natural causes. In only one case could death be directly attributable to lambing when in poor condition.

A Grazier Replies.

Mr. C. B. Blyth, of Boolcaroll, Wee Waa, N.S.W., who first introduced the matter to the Graziers' Association, replies as follows:—

(*a*) So far as graziers are concerned, they *cannot* save their lambs without green feed. I have tried lucerne hay—it kills the lambs. I have tried ensilage from natural growth—it also kills the lambs. Bran and molasses must be fed in troughs. It is quite impossible to feed large numbers of ewes and lambs in troughs—they would smother—another thing—it is quite impossible to get, say, 2,000 ewes with lambs all lined up at the troughing nicely—so that each one will get an equal share—there would be struggling masses at one place and none at all at other places—some would get a lot of feed and others no feed at all.

(*b*) I note you say the fodder would be required only in drought years. It is not the big drought, like 1902, that graziers want the fodder for. it is for the numerous dry snaps which occur in the Western country every year, generally twice a year, in this district during every lambing time for the past five years. If a suitable fodder is put up at a reasonable cost, there is no doubt graziers will use it.

(*c*) In regard to laying in a reserve of feed. Graziers cannot do it. The flush season which allows of the cutting of surplus feed occurs only once in five years in this district, and further west, once in ten years, and to enable a grazier to cut the surplus feed he must have on hand ten mowing machines, and the necessary rakes, drays, harness, &c., also at least 45 draught horses and their harness. The work must be done inside four weeks, because the feed would not keep at the right stage for a longer period. The grazier would have to keep all that amount of machinery, harness, &c., together with 45 horses, for five years for one month's work. And cut ½ ton, or, at most, 1 ton of feed to the acre. No man can afford to do it. Besides, the necessary workers with experience as not available.

(*d*) I take it that molasses, in conjunction with ordinary stock foods, must be fed in troughs. Graziers cannot feed their sheep in troughs.

(*e*) I am getting some "Molerne," and will try it.

(*f*) Farmers can conserve feed, who only carry 500 sheep or under—they always carry the necessary plant and horses, and 500 sheep do not require much feed. But graziers do not carry either plant or horses, and their sheep require an enormous amount of feed.

In conclusion, I would like to state that I have been managing stations for the Australian Estates and Mortgage Company, in Western New South Wales and Queensland, for the past 26 years, and I have seen probably 50 dry snaps during that time. Fortunately, not always at lambing time. But very often. I have been managing this property for the same company for thirteen years, and have made pit ensilage from natural growth, whenever possible, and as much as my plant and horses can cope with—none, however, since 1913, as there was no flush season since then.

Graziers require a fodder that is available at all time. Something put up in small cake, or marble form, that can be thrown out to the sheep on the ground. Something that speculators cannot corner. Something that can be kept in silos without deterioration—under Federal Government control. Immediately graziers are short of feed, or have to start buying maize, lucerne, chaff, &c., speculators come in and corner the market, and the price goes beyond reach.

If you can test the different fodders grown in Australia, and by experiment arrive at the fodder, or combination of fodders, necessary to save the lives of ewes and lambs and other sheep—then encourage the manufacturers to put it up in suitable form, induce the Federal Government to buy it from them, and store it in large quantities in silos, where graziers could get it whenever required—then the enormous losses of sheep would cease, Australia would be twice as prosperous as now, and farmers, who are now leading a hand-to-mouth existence growing wheat, would grow the necessary fodders, and soon be in a prosperous state. If farmers were certain of a reasonable price, they would, and could, grow all the fodder that Australia requires during droughts.

The matter is a national one, and should be taken up by the Federal Government as early as possible.

Australia loses millions of money through drought. And this matter of providing a suitable fodder for starving stock is, without a doubt, *the* most important matter to be dealt with.

I note what you say about propaganda work—it would do good amongst small holders in good rainfall country, but would do no good whatever amongst graziers in the west. They have all tried conserving fodder, and have all given it up. Some have tried irrigation from the rivers, but the plants are all idle now.

Graziers cannot be blamed for losses in sheep—they do their best to save their sheep. If there is a drought on, and there is no rain to make feed, and they cannot buy feed at a reasonable price, they can do nothing but let their sheep die.

TEMPERING DROUGHTS.

SCIENTISTS IN REPLY.

Fodder for Lambing Ewes and Lambs.

The points raised by Mr. Blyth were submitted to Professor Watt and to Mr. Richardson. Their comments are summarized as follow:—

Professor Watt—

(*a*) Information from farmers, pastoralists, and officials of the New South Wales Agricultural Department did not agree with Mr. Blyth's statement, that lucerne hay or silage made from natural growth killed lambs.

(*b*) The methods previously suggested—feeding on lucerne or other hay, silage, and perhaps a little grain or bran and molasses—would be even more suitable for short, dry spells than for prolonged droughts.

(*c*) If dry spells occurred with the frequency mentioned by Mr. Blyth it was absolutely essential to lay in a reserve of food. It should be a good business proposition to lay in a store of lucerne hay in bales when the price was low, as the stuff did not deteriorate.

Dealing with the proposal generally, he points out—

"It would undoubtedly be a tremendous advantage to graziers if an ideal foodstuff, in ideal form for feeding, which would not deteriorate, could be prepared, and stored by the Federal Government, or some other agency, and sold during drought times at a reasonable price.

"The solution of this problem would probably, however, be more difficult than the present problem before the graziers. I would repeat, that if lambing ewes and lambs are to be brought successfully through a dry spell, part of the ideal ration should be succulent, and no succulent feeding-stuff would keep for an indefinite period unless it could be conserved away from the air, or in a silage pit. Owing to its bulk and deterioration after the pit is opened for any length of time, the only place to store it is on the station, near where it is to be fed. If graziers could conserve enough silage it might be feasible for the Government, or for an association of the graziers themselves, to buy the dry part of the ration on a cheap market, and store for sale when a dry spell comes to any district.

"I do not agree with Mr. Blyth's statement that all graziers have tried conserving fodder, and have all given it up, or that the irrigation plants are all idle now. The high prices ruling for stock may help to resuscitate those that are idle now. I agree that the losses of stock during droughts are of national importance, especially at the present time, when the whole of the energies of the people in Australia should be concentrated on increasing production, and especially primary production.

"Although further research into the ideal food, or combination of foods, for lambing ewes and lambs is very desirable, I agree with Mr. Richardson, that propaganda work is even more important."

Mr. Richardson—

(*a*) Ensilage, lucerne hay damped with water and molasses, bran and oats were extensively used in Victoria during the last drought with highly successful results.

(*b*) Any cake that could be put upon the market must necessarily cost a great deal more than the sum of the costs of the component parts of the cake. Any cake evolved must necessarily be mainly composed of the foodstuffs which are grown in Australia, *e.g.*, cereal hay, lucerne, grains, together with such supplementary material as bran, oil cake, linseed, or molasses.

Dealing with the proposal generally, he points out—

(*c*) "The forages, other than grains, available in greatest quantity in Australia are wheaten, oaten, and lucerne hay, and these must form the bulk of the ration fed to stock in times of drought. The best method of utilizing these various forages, in combination with other foodstuffs, *e.g.*, molasses, brewery by-products, bran, linseed, in times of drought for feeding young lambs, has not been the subject of systematic investigation, and there is no doubt that such work would be of considerable value to Australia. It might well be a problem

for co-operative investigation by the States and the Institute of Science and Industry. The New South Wales Department of Agriculture, with its numerous experiment stations, some of which are located in the arid regions, has special facilities for work of this nature."

(*d*) "Mr. Blyth says the graziers require a fodder that is available at all times; something that can be put up in cake or marble form, that can be thrown (or fired (?)) to the sheep. Something that the speculators cannot corner. Something that can be kept in silos without deterioration. The fodder which answers best to these requirements is oats, or perhaps barley, conserved in a silo. Many of the wheat growers of Victoria are erecting silos for the especial purpose of conserving oats for feeding their sheep in dry periods. Normally, oats are the cheapest of all grain foods, and are especially suitable for feeding to sheep. In most years they can be purchased, f.o.b. at Australian ports, at 2s. per bushel (£5 12s. per ton), and can be conserved in silos without deterioration for years. They can be made the basis of any drought ration, and supplemented with straw, hay, molasses, bran, &c."

The man of science has learned to believe in justification, not by faith, but by verification.

HUXLEY.

Cotton: Its Cultivation in Australia.

By GERALD LIGHTFOOT, M.A.

BEFORE seriously considering the possibility of making cotton-growing one of the staple industries of the Commonwealth, it is first essential to know the facts. These I have endeavoured to collate and present in a concise form. The information may be grouped under two headings—(1) that collected by the Institute; and (2) that gathered in the United States by the Commonwealth Board of Trade, through inquiries set afoot by Mr. H. Y. Braddon. Both are given as follows:—

(1) Information Collected and Action Taken by the Institute of Science and Industry.

1. Cotton growing has been tried for many years on a small scale in Queensland, but, except for a short period, without any marked success. As a result of the American Civil War, with the inducement offered by the high prices of cotton, Queensland exported 26,000,000 lbs. of ginned cotton, valued at £1,300,000 sterling, but since then the industry has declined. Thus in 1914 only 214 acres were devoted to the purpose, the yield being 35,230 lbs. of unginned cotton, valued at £881. This acreage was made up of a relatively large number of small cultivated areas. Small areas in the Northern Territory have also been planted with cotton, while the tropical parts of Western Australia have long been regarded as suitable for its cultivation. It appears that there would be few, if any, natural difficulties in growing large quantities of cotton in Australia.

2. The chief difficulty which has prevented the successful establishment of the cotton industry in Australia on a large scale seems to be the high cost of picking by hand. This is due partly to inexperience, there being no body of skilled pickers familiar with the crop, and partly to the high rates of wages prevailing in Australia compared with the other cotton growing countries, where coloured labour is available. Certain authorities in Queensland consider that the best way to overcome the labour difficulty would be to encourage farmers to grow small crops—say 10 acres—of cotton in addition to other crops, and it is considered by these authorities that a family of four persons could easily pick the cotton produced on such an area without extra assistance.

3. Efforts have been made by the Commonwealth Government to encourage cotton growing. Under the *Bounties Act* 1907, a bounty at the rate of 10 per cent. on market value was offered on cotton grown and ginned in Australia, the maximum amount of bonus which might be assigned for that purpose in any one year being £6,000. The amount paid in 1914 was, however, only £21. Cotton ginning on a small scale has been carried on intermittently in Queensland for a number of years. By reason of the high price for cotton now prevailing there has recently been some extension in the area cultivated. The total quantity of raw cotton received at the Queensland Department of Agriculture Ginnery was 9,500 lbs. in 1914, and 166,000 lbs. in 1918.

4. In 1916 members of the Executive Committee of the Institute inspected, in Queensland, certain mechanical devices for the picking of cotton, and formed the opinion that, if properly designed and improved, the possibility of developing an efficient picker offered a reasonable chance of success. The committee is of the opinion that with the introduction of an efficient mechanical cotton picker the industry will become firmly established, since the soil and climatic conditions in Australia appear eminently suitable for the growth of the crop; but before mechanical cotton pickers can be used economically cultivation must be established on a fairly large scale.

5. After making inquiries from numerous sources, and after taking steps to procure from the United States of America copies of all patent specifications relating to mechanical pickers, the Executive, in August, 1917, appointed a Special Committee in Queensland to carry out experimental work, with a view to devising an efficient picker. The Special Committee, after examining various methods hitherto proposed, and after carrying out a considerable amount of experimental work, has concluded that mechanical picking must be limited to certain tractable varieties of cotton; that is to say, varieties in which the calyx opens wide and the seeds are comparatively loose. Mr. D. Jones, formerly Cotton Expert of the Queensland Department of Agriculture and Stock, and a

member of the Special Committee, visited various parts of Queensland, and obtained the seed of suitable varieties; he considers that a suitable type of cotton of equal value to the intractable types can be cultivated successfully. As regards the machine picker, previous inventions have usually been operated on the air suction principle, similar to the working of a vacuum cleaner. The Committee has, however, come to the conclusion that steam is likely to be not only economical, but also more effective than air. A design for a machine has been got out as a result of the experimental work, and small areas of tractable cotton have been planted in the vicinity of Brisbane, for the purpose of carrying out field tests. With that object, the Committee in Brisbane is arranging to have an experimental machine constructed. It should be mentioned that, owing to adverse weather conditions, the experimental plots near Brisbane have not been entirely successful.

6. The possibility of establishing the cotton growing industry in Australia on an economic basis will, of course, depend on the securing of markets at a profitable price. It is stated that the Queensland cotton is of very high quality. Large quantities of canvas, dungarees, and other cotton materials required for the equipment of the Australian Naval and Military Forces are imported into Australia. The imports of cotton goods give some idea of the magnitude of the total requirements of the Commonwealth, the total value of the cotton piece goods imported in 1913 being over £3,000,000. In addition, raw cotton to the value of over £20,000, as well as large quantities of cotton wearing apparel and other cotton goods, were imported. The general rate of duty on cotton piece goods is 5 per cent., with a preferential tariff (free) to the United Kingdom. No cotton spinning or weaving is carried on in Australia, and the establishment of cotton manufacturing industries must depend very largely on fiscal consideration, a matter which is outside the purview of the Institute of Science and Industry.

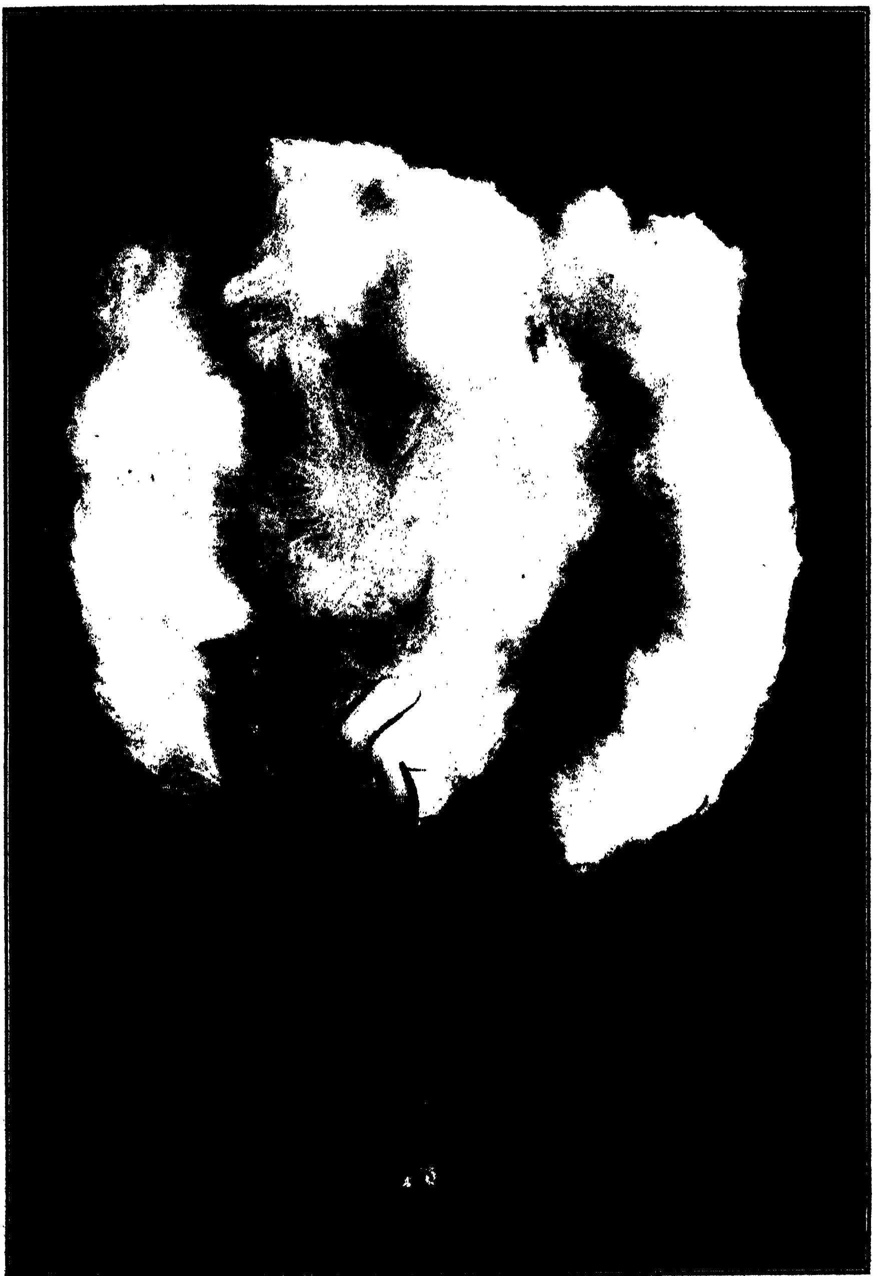
The Queensland Cotton Manufacturing Company closed down its works at East Ipswich, Queensland, after a period of five years, partly owing to insufficient capital, but mainly to the fact that the company, having devoted its efforts largely to the manufacture of towels (on which there was an import duty of 15 per cent.), the importers of cotton goods found that by importing towels in bolts, the selvedge being uncut, the material was classed as "piece goods," and admitted duty free.

7. The Executive Committee experienced difficulty in obtaining in Australia the opinion and advice of properly qualified experts on the whole subject, the knowledge available in Australia being almost entirely local and empirical. In September, 1916, the Committee communicated with the British Department of Scientific and Industrial Research, setting out the facts of the case, and asking whether any person possessing the requisite qualifications would be readily obtainable to visit Australia and report, not only on the growing and picking of the cotton, but also on its marketing. The British authorities stated, in reply, that it did not then appear practicable to secure the services of an expert from Great Britain to visit Australia for the purpose proposed. The Department stated that the Chairman of the British Cotton Growing Association, who was confidentially consulted, said that his association would probably be able to take the necessary steps with regard to the marketing of Australian cotton, and that owing to long experience his association was exceptionally qualified to deal with small lots of new crops.

8. In May, 1917, the Executive Committee wrote a similar letter to Mr. F. Taylor, Cotton Technologist, Department of Agriculture, U.S.A., asking if the services of an expert could be obtained to advise on the matter indicated. In his reply, Mr. Taylor made the following comments:—

> "We have no information to justify a belief in this manner (*i.e.*, mechanical cotton pickers) of solving the labour problems in regard to cotton production either in Queensland or elsewhere. It does not appear that the cost of picking should be prohibitive if the natural conditions are in reality eminently suitable for the production of a cotton crop. . . ."
>
> "It is a mistake to suppose that cheap tropical labour is necessary for cotton production if good yields are obtained. Our experience in the Salt River Valley of Arizona indicated that few crops are more responsive to intelligent handling than cotton. . . ."

Mr. Taylor also said that the yield of cotton in Australia, as shown by the statistics, indicated either very unfavorable conditions or inferior methods. He said that the sending of qualified men by his Department to study the production



[Photo. Queensland Department of Agriculture.

RUSSELL'S BIG BOLL. GROWN AT MELTON, BRISBANE.

and marketing problems, and to advise regarding the different features of the undertaking might be possible on the basis of a recognised co-operative arrangement, and he stated that if a formal request from the Institute of Science and Industry for such co-operation were received, he would bring the matter up for determination.

Commenting on Mr. Taylor's letter, Mr. Daniel Jones said that he had frequently found occasion to question the value of official statistics in Australia regarding the yield of cotton. He said that Queensland obtained a much larger yield per acre than can be obtained in the United States of America. He thought that natural conditions in Queensland would more than compensate for even higher cost of labour than in other countries. He also considered that, in view of the close knowledge possessed in Australia of the habits in this country of the cotton shrub, and of the fact that the climatic and other conditions are totally different in Australia to those of the cotton regions in America, the only practical information of value which American experts could furnish is in connexion with up-to-date machinery for ginning the fibre.

9. The ginning and marketing of the cotton in Queensland is carried out by the Queensland Department of Agriculture and Stock. Growers receive an advance on delivery of the cotton in the seed, and the balance, if any, is paid to them after the sale of the product. Last season (1918) an advance at the rate of 2d. per lb. was made, and the price eventually received by the cultivators was 4d. per lb. The lint realized 1s. 1d. per lb.

10. As indicated above, the Executive has obtained from America a large amount of information *re* inventions for mechanical cotton pickers. As far as can be ascertained, an efficient mechanical picker has not been devised in that country. Statements recently made in the Melbourne press to the effect that mechanical pickers are used in the United States of America appear to be incorrect. It is impracticable to forecast whether an efficient picker will be devised as a result of the experiments which are being carried out by the Advisory Council at Brisbane.

Though the cultivation of cotton on extensive areas may be impracticable in Queensland owing to labour conditions until an efficient mechanical picker is devised, the extension of cultivation on small areas may be considerably extended if a suitable price is offered to the farmers.

11. The position in regard to cotton in the British Empire is dealt with in a report recently issued by the Departmental Committee appointed by the Board of Trade to consider the position of the textile trades after the war (Cd. 9070, 1918). The Committee recommends, *inter alia*, that the British Government should immediately appoint a Special Committee to investigate in all its bearings the question of increasing the supply of cotton in the British Empire.

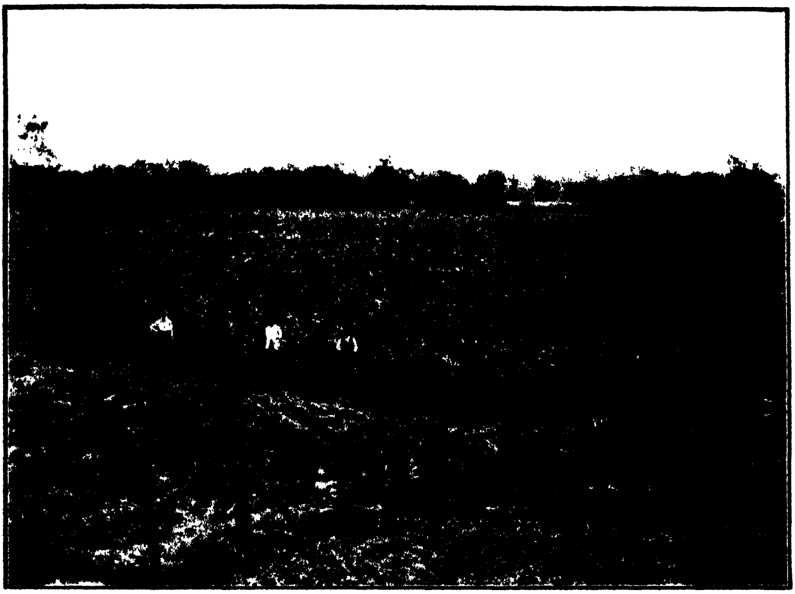
12. The Executive Committee is of the opinion that the cultivation of cotton in Australia would be considerably extended if a suitable price were guaranteed. This might be done in the same way as that adopted in the purchase of flax under the Commonwealth Flax Industry Regulations. From information received by the Committee it appears that if cotton were produced in anything like a considerable quantity capital would be forthcoming for the establishment of factories for the treatment of the raw material, especially for the manufacture of coarser fabrics.

13. In May, 1913, following upon representations made by the Dominions Royal Commission, the Commonwealth Government agreed to contribute up to £500 towards the expenses of an expert to visit Australia for the purpose of examining the possibilities of extending the cultivation of cotton. This offer was communicated to the British Cotton Growing Association, and, after certain negotiations, it was decided that instead of obtaining an expert to visit Australia, a specialist in cotton growing should be employed for three years in connexion with the Queensland Department of Agriculture, the Commonwealth to contribute £500 towards his salary. No further progress was, however, made towards the appointment of a specialist, though the necessary funds were provided on the Commonwealth Estimates.

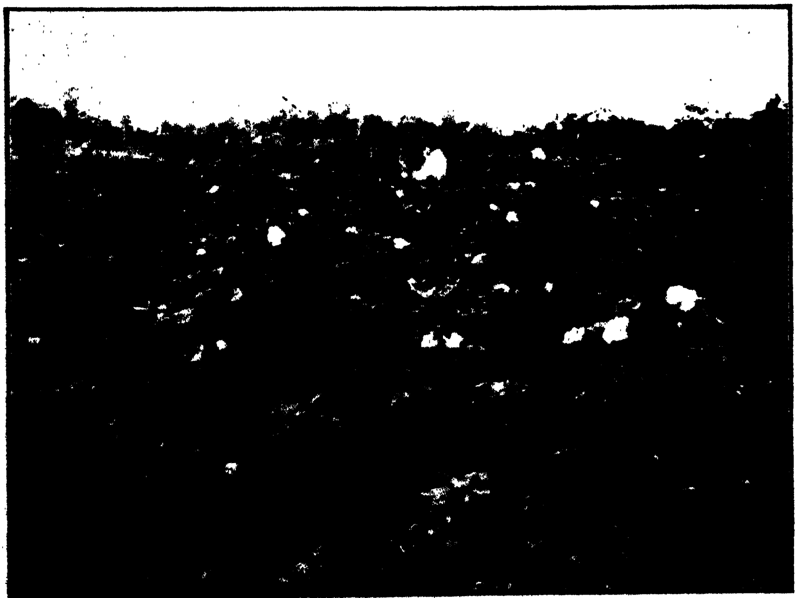
If it be decided to engage the services of an expert to investigate and report on the matter, the Executive Committee is of the opinion that he should carry out his work under the ægis of the Institute of Science and Industry.

(2) Information Collected and Action taken by the Commonwealth Board of Trade.

14. In September, 1918, a memorandum on the above lines was furnished by the Institute of Science and Industry to the Commonwealth Board of Trade, which has since taken further action in the matter, especially in respect to



COTTON AT STANWELL, CENTRAL QUEENSLAND.



COTTON AT IPSWICH, QUEENSLAND.

obtaining a report from the Commonwealth Trade Commissioner in America, who sent an officer to Washington to discuss the whole question with officers of the United States of America Bureau of Plant Industry.

15. The information obtained by that officer may be summarized as follows:—

(*a*) *Mechanical Devices.*—The only use made in America of mechanical pickers is for gathering what is known as "bolly" cotton and "snap" cotton. Bolly cotton is a term applied to the pods which, through certain conditions, do not reach maturity. Snap cotton occurs when the plants have been left in the fields too long, and the fibre has become brittle. Rather than allow cotton of this type to run to waste it is picked by machinery. Cotton pickers for ordinary healthy crops are not in use in the United States of America.

(*b*) *Types of Cotton.*—There are some 200 different varieties of cotton. Many districts in America have their parallel as regards soil and climate in Australia, and in these districts in the United States of America many varieties of cotton are grown profitably. Under similar conditions the same types could probably be cultivated successfully in many parts of Australia.

COTTON AT NORTH COAST, QUEENSLAND.

The experts to the Bureau of Plant Industry agree absolutely that the only way to approach the matter is by experimentation. Before the cotton-growing industry can be successfully established in Australia, experiments will have to be made exactly in the same way as has been done with wheat growing and wool production.

When new districts are being opened up in America, different varieties are treated to ascertain which gives the best results. The experts of the Bureau strongly advise that a selection of the best American varieties should be planted, and tested under various conditions in Australia. They thought that parts of Australia outside Queensland should produce good results where the temperatures are lower and the rainfall heavier than in Queensland. In America, cotton grows best with a rainfall at the right period of from 20 to 30 inches, followed by warm weather.

(*c*) *Labour Conditions.*—The question of coloured labour has no direct bearing on American cotton production. There are many districts in which

all the cotton is sown, cultivated, and picked by whites. The black labour employed is not much over half the total. At the same time the proportion of *hired* white labour is small.

(*d*) *Cost of Production.*—The main cost is that of picking. The present rate of wages (white and black being paid exactly the same) is $1.25 per 100 lbs. of seed cotton. The seed is mechanically drilled at a cost of $3 to $7 per acre sown. It takes from 25 to 40 acres of fair average quality land to support a man and his family, the average production per acre being from about 185 to 190 lbs. of lint cotton. It takes 3 lbs. seed cotton to produce 1 lb. lint cotton, and there remains over 2 lbs. of seed, worth 3 cents per lb. The price of lint cotton with 1-in. staple is 27 cents per lb.

(*e*) *Spinning.*—The expert of the Bureau thought that Australia might, perhaps, make a commencement with low-grade articles, like twines and ropes, in the manufacture of which the processes are simple and the machinery cheap. The successful manufacture of a wide range of articles could only come after a long period of experience, and when a market exists for the disposal of diverse goods.

16. Mr. Braddon states that, in his opinion, no mechanical picker is likely to be discovered for picking cotton of good crops. His opinion is based on the fact that the crop does not ripen simultaneously, and, in the process of picking, selection by eye of the riper pods is a necessary factor.

17. Whilst the Commonwealth Board of Trade does not consider that the present prospects of substantially increasing the production of cotton are very encouraging, in view of the importance of the matter, they are obtaining information as to the requirements of the Department of Defence and the Australian Woollen Mills.

18. The Board of Trade has also suggested to the Under Secretary, Department of Agriculture and Stock, Brisbane, that he and his Departmental Adviser might confer with the Board in Melbourne in regard to the best means of developing the industry.

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavouring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find by ones experienced in the direction of research. All research professors know that the finding of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

—RAYMOND F. BACON.

"The Administrator of Industrial Research Laboratories."

Organization of Industrial Research.

By ARTHUR D. LITTLE.*

The war, which has changed everything, has given a new aspect to research. Hereafter the nation which would live must know. Through the wreck and peril of other peoples, Americans have learned with them that research has something more to offer than intellectual satisfactions or material prosperity. It has become a destructive as well as a creative agency, and in its sinister phase the only weapon with which it may be fought is more research. The organization and intensive prosecution of research has thus become a fundamental and patriotic duty which can neither be ignored nor set aside without imperilling our national existence.

In considering any plan for the organization of research, one is immediately confronted by the difficulty that science in its highest expression is essentially individualistic and democratic. It resents autocratic control, languishes and becomes sterile under minute oversight and direction from outside. The great advances in human knowledge have almost invariably been due to individual effort set in motion by the scientific imagination and sustained by a consuming desire to ascertain the truth. Pasteur, Curie, and Rutherford were not dependent on organization for their results. They worked to the best advantage in proportion as they were free to follow the vision which moved before them. No amount of organization can make a Faraday. It may, perhaps, discover one, and is then privileged to provide encouragement, working facilities, and recognition. With these assured, it is the part of wisdom to leave him as much alone as possible.

Any really effective plan of research organization must provide for the exceptional man, the man whose angles have not been ground down, who is sometimes not comfortable to rub against, but who has the spark of genius. He is usually a man who hates rules and systems, regular hours, time slips, and all the paraphernalia of organization. Organization can help him none the less by relieving him of burdens, making him master of his own time, furnishing equipment, providing organized and immediately available library facilities, and by directing his attention to specific problems.

While the superlative work in science, like the superlative work in art, must always be an expression of the genius of the individual, and quite beyond the power of organization to insure, there remains a vast deal of what may be called the secondary work of rounding out the great discoveries, and especially of giving them an industrial application, which may be rendered most effective only through proper organization. The nimbus which, just at this time, surrounds the word "research" should not blind us to the fact that research involves a great deal of hack work, work for good honest plodders, who accumulate the data which permits or confirms the generalization, or which is required to give it practical effect.

Broadly stated, the aims of research organization should be:—

1. To find, develop, and train men.

2. To create such a background in the public mind as shall insure support for research and the industrial utilization of research results.

3. To secure co-operation between different branches of science, as, for example, between chemists and mathematicians. The fortuitous combination of the

*President, Arthur D. Little, Inc.

mathematical mind with the viewpoint of the chemist in Willard Gibbs laid the basis for physical chemistry. But such a combination in a single individual is very rare.

4 To avoid repetition and duplication of effort, first by rendering present knowledge readily available to research workers, second by applying clearing house methods to research projects.

5. To stimulate research by emphasizing the importance of specific problems, making special grants, rendering material and facilities as generally available as possible.

6. To furnish a sort of general staff for research which shall work out the plan of attack for major problems, assign the several lines to competent workers, and coordinate and focus the whole.

7. To bring home to manufacturers the advantages of research with the view of promoting the establishment of private, corporation, and group laboratories.

8. To make and publish a census of available research facilities in men and equipment.

9. To survey the natural resources of the nation, and direct research toward their development.

10. To appraise our great industrial wastes, and develop plans and methods for turning them to profitable use.

There is a nearly universal tendency to attempt the accomplishment of these results through the agency of councils and other forms of committee organizations, the members of which are almost without exception unpaid and involved in other activities which have prior claims upon their time. While such systems of organization may be temporarily efficient, and even the only ones immediately available in times of sudden crisis, they do not lend themselves effectively to the slow, constructive work of years without which it is impossible to establish research in its proper place in the industrial and other activities of a nation.

There is danger in an organization chart: danger that it be mistaken for an organization.

The work of committees is notoriously cumbersome and slow. The capacity of a committee to achieve results is usually determined by its chairman, and is somewhat below his normal working ability as a unit. The reference is, of course, to executive capacity and ability. In the initial discussion and formulation of plans and policies committees plan an essential and most useful part.

As the committee organization is extended to cover the diverging ramifications of a many-phased activity, the inherent weakness, for executive purposes, of this form of organization becomes increasingly apparent. More and more power must be developed by the central body to overcome the inertia of the augmented mass. The whole may ultimately break down from its own weight.

It appears, then, that we may have still to evolve a permanent, coherent, and progressively effective form of organization for the promotion and co-ordination of research. This may, perhaps, appear in the shape of a great foundation closely affiliated with the Government, the universities, the technical societies, and the industries, which shall have its broad policies directed by a board, wholly divorced from politics, yet intimately in touch with the trend of science and the needs of industry, and which shall depend for the execution of its plans upon a permanent executive and well-paid scientific staff.

Any permanent research structure of national dimensions must of course have its foundations in the universities and technical schools. Unfortunately, in this time of greatest need, these institutions are seriously handicapped by the very

generosity of their response to the demands already made upon them. In the scientific departments the instructing staff has been heavily drawn upon for special service, and those who remain are carrying a greatly increased burden. Students are distracted by war interests, and are constantly being diverted into military activities.

While recognising the exigencies of the period, and applauding the splendid response of Americal institutions of learning, it may not be ungracious or premature to indicate some of the directions in which these institutions must ultimately move if they are finally to meet the augmenting demands for research and for graduates fitted to cope with industrial research problems.

It is beginning to be recognised that there is no valid distinction between scientific research and industrial research. Both employ the same methods and the same equipment. The demands of either may involve and tax the highest intellectual faculties, and industrial research frequently necessitates that nicety of refinement and subtlety of attack which characterizes the highest scientific effort. There remains only the shifting and uncertain line of demarcation which may indeed be found in motive. In the selection of thesis subjects and minor research problems greater prominence may therefore well be given to those having a direct industrial application.

Industry must, however, continue to look to the higher institutions of learning for the determination of fundamental facts and constants, the development of theory, and the establishment of general principles. Any adequate response to this demand requires that professors and assistants should have far more time available for research than is now at their disposal. They must have some substantial measure of relief from routine and administrative detail. They should, and undoubtedly will, have more direct contact with the industries. As a consequence, more and more of them will undoubtedly be drawn into industrial positions. This will mean no ultimate disaster to the cause of scientific education, provided university authorities recognise the patent fact that the day has come when much larger salaries must be paid and greater distinction accrue to capable men of science who are to continue as professors. With improvement of status, the exceptional men will demand greater freedom of decision and action. They will be less bound by academic system, and let us hope that, as their capacity for research is demonstrated, they will resist the influences which would tend to make them mere administrators.

The expanding recognition of the part which applied science is destined to play in our national development would seem to insure an adequate supply of scientific students, and especially of candidates for degrees in chemistry and chemical engineering. Let us see to it at the start that they are provided with a broader culture than has heretofore obtained in many places, lest they be incapable as scholars of meeting their great responsibilities. Concurrently we must provide means for correcting the recognised deficiencies in their professional training, which have been pointed out times without number in the hundreds of papers on the education of the chemist and chemical engineer which have been published during the last few years.

We must organize our research with the means and men at hand, and look hopefully to the future for accessions of human material of higher average training and far broader scholarship.

Since the frontier of knowledge is the starting point of research, the energy of the explorer must be conserved on his way to the frontier. In no way, therefore, can organized co-operation render more effective service to research than by

making readily accessible those vast stores of specialized knowledge which research has already accumulated, but which still require to be brought into that systematized and orderly arrangement which characterizes science. The research laboratory should be built around a library. These special libraries should be linked together, and closely affiliated with the great libraries of the wrold. Such admirable journals as *Chemical Abstracts* should be substantially endowed, the publication of monographs encouraged and assisted, while systematic reviews and reports of progress covering limited special fields in science and technology should appear far more frequently. The intensive collection of scientific and technical information throughout the world, its codification and its distribution, might well be made a governmental function to an extent not now approached.

Experience has shown that, in the organization and conduct of industrial research laboratories, certain well-established principles are of general application.

It is desirable that the laboratory be separately housed, and that an institutional atmosphere be developed and maintained. It should be recognised that research is necessarily expensive, and that results are not forthcoming over night. The ovulation of ideas takes time, and their material embodiment proceeds slowly, and seldom can be hastened without danger. Adequate equipment, which is often costly, is essential for good work, and a liberal policy must be followed where requisitions are concerned. It is well to have the laboratory expenditure arranged on the appropriation system, and to allow the director a free hand within the appropriation. If the laboratory is a part of an industrial organization, it should maintain close contact through conferences and reports with all departments of the organization; but no department should be allowed to dominate the laboratory, and its director should be responsible only to the executive of the corporation. Since no organization can include every department of human knowledge, the director should be encouraged to make frequent use of the advice and services of outside specialists.

"The gods send threads to webs begun," which is the classical way of saying that we have to get into the water to learn to swim. It is, therefore, well, in case of major problems, to start somewhere as well as may be, even though the starting ground be not wholly to one's liking. It is easily possible to spend too much time in preliminary searches of the literature, and better to avail of early enthusiasms in some initial work at least, while carrying on concurrently the tedious task of reviewing and abstracting literature.

Nothing is more expensive or demoralizing than experimentation in the plant. An industrial research laboratory should, therefore, be adequately provided with equipment of semi-commercial size. Infant mortality among processes is high in any case, and the most critical period in their young lives is that covering the transition from the laboratory to the plant. They require, and the research laboratory should provide, a nursery to protect and foster them during this period of their development. Some large manufacturers have even found it desirable to operate in connexion with and under the sole direction of their research laboratory a small plant in which actual commercial manufacture is regularly conducted. Such extension of the laboratory's function permits the complete reduction to practice of new methods, and the commercial demonstration of the sufficiency of the product before the innovations are introduced into the main plant.

Even when no such provision appears feasible, it is, nevertheless, highly desirable to have the industrial research laboratory actually engaged in some

small scale, highly specialized, commercial manufacture, preferably of some product which it has itself originated. The least advantage of this procedure is that such manufacture of a properly selected product may frequently defray a substantial proportion of the expenses of the laboratory. The major benefits are the acquirement of a certain commercial sense by the laboratory staff, an appreciation of the conditions and difficulties of actual production, and finally the strengthening of the position of the laboratory through the increase in its turn-over and equipment. Such procedure, while perhaps not general, has been followed to great advantage by the research laboratories of the General Electric Co., the Eastman Kodak Co., and Arthur D. Little, Inc.

As regards any research laboratory, it goes without saying that it is the personal factor which determines performance, and this is pre-eminently true of the laboratory director. Sir Humphry Davy truly said that his greatest discovery was Michael Faraday, and no greater problem is likely to confront a research laboratory than that involved in the discovery of a director. Successful laboratory directors may be of several types, but a militant optimism, contagious enthusiasm, controlled imagination, and quick human sympathy are common to them all. Such a man will naturally, in selecting his subordinates, look for these personal qualities almost as carefully as he will weigh specialized scientific training, and having been thus guided in his selections will find it relatively easy to inspire throughout his organization those relations of good fellowship and that *esprit de corps* which multiply enormously the effectiveness of any working force.

Exceptional men are hard to find, simply because they are exceptional, and the director, in laying out the work of the laboratory and extending its *personnel*, will endeavour to augment the output of the exceptional man through the co-ordinated effort of properly directed men of secondary capacity.

Fairness in apportioning credit, frequent conferences, and opportunity for self-development are essential to the attainment of high efficiency.

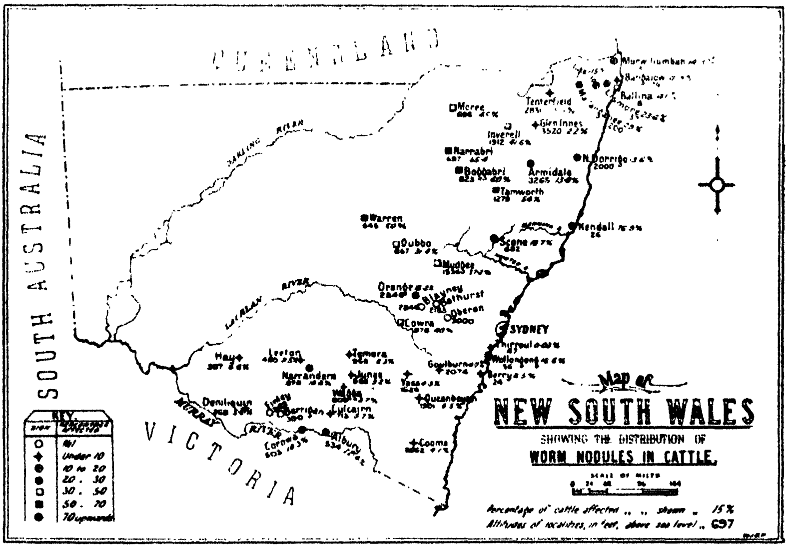
Among laboratories thus constituted and directed, co-operation should not be difficult, and is, in fact, already frequent. The real need of the situation is co-operation among manufacturers for the support of research. The long first steps in this direction have already been taken in Great Britain by the Advisory Council for Scientific and Industrial Research. In the United States of America, the National Canners Association has been signally successful in applying to research the principle of co-operation.

Those of us who believe that every waste that is prevented or turned to profit, every specification which gives better control of raw material, every problem solved, and every more effective process which is developed, makes for better living in the material sense, and for cleaner and more wholesome living in the higher sense, can render no more effective service than by aiding the manufacturer to understand what research is, what it costs, why it pays.

The Distribution in New South Wales of Worm Nodules in Cattle due to *Onchocerca gibsoni.*

By J. Burton Cleland, M.D.,
and
Bessie M. Somerville, B.Sc.

In Bulletin No. 2, entitled "Worm Nodules in Cattle," the Institute of Science and Industry published some results, obtained by Dairy Inspectors, showing the geographical distribution in New South Wales of worm nodules due to *Onchocerca gibsoni* (Jnstn. and Cld.). It has been felt that these returns were not sufficiently extensive, and that a systematic examination by one or two individuals might reveal more clearly the relative prevalence of these worm nodules in different parts of the State. With this object in view, Miss Somerville was appointed by the Advisory Council to supplement the examinations already made, or then being made, by one (J.B.C.) of the sub-Committee on Worm Nodules in Cattle.



The accompanying report is the result of the examinations thus made, and may have a very important bearing in elucidating the life history of the worm in question.

This survey was begun with the intention of ascertaining in what parts of the State local cattle do not develop worm nodules; in what parts they occasionally do so; and in what places the nodules are common, or even extremely abundant. It was thought that if reliable information could be obtained from a great portion of this State, some light might be thrown on the means by which the larvæ are conveyed from one bovine to another. Obviously if in some places local cattle never develop worm nodules, in spite of the introduction into the herds to which they belong of cattle with worm nests from other districts, then the means of transmission must, for some reason, be defective in the district in question. If, on the other hand, locally-developed nodules are few, one may infer that the transmitting vector is present but not common, or that some other factor renders transmission difficult. Again, where local nodules are common, the vectors are

presumably relatively abundant, and no difficulties exist as regards transmission. If two places, with dissimilar climatic conditions, both show a prevalence of worm nodules in their local cattle, then there must be some common factor, presumably a common vector, linking those two localities together, but separating them from places where worm nodules do not develop.

It was with the above object in view that this investigation was undertaken, and the results of the survey fully warrant the time and trouble expended in the undertaking. Some remarkable and unusual results have been obtained, from which, after careful perusal and more thorough investigation, important points may emerge, either at our own hands or at those of others whose attention may be directed to the matter. Thus we find that, in certain highly-situated places on the central tablelands, namely, Oberon, Bathurst, and Blayney, worm nodules were not detected in the cattle. In the Riverina, and on the south-western slopes in general, with one or two partial exceptions, in the southern tablelands, in the New England district, in the Sydney district, and in portions of the north and south coast, worm nodules are few. Whilst the southern tablelands and New England district perhaps owe their fewness of worm nests to the same conditions that render those absent in the Bathurst and Blayney districts, it is probable that in the Riverina and slopes and in various parts of the coastal area other factors are responsible. In the neighbourhood of Sydney this may be due to the nearness of human habitations which, were March flies the vectors, would certainly tend to make them less numerous. In other cases it may be due to the clearing of land from timber, and putting it under cultivation, which may be deleterious to the abundance of the vector. We find on the central western slope at Dubbo, in the central tablelands at Mudgee, at Inverell, at Tamworth, and in the north-western plains, that worm nodules are frequent, whilst the heaviest infestation of all has been found at Kendall, the site fortunately chosen by us for our special investigations. It is clear that at Kendall exceptionally favorable conditions occur for the transmission of the larval worms, and that in the other places just mentioned very good conditions, though not such perfect ones, exist. These two types of district are very dissimilar in climate and in surroundings, and yet they must possess some common factor which is less operative in the Riverina or the cold high tablelands.

Though these points bring out in general the results obtained, a number of anomalies exist. Thus we find in certain districts that different towns, or even dairies close together near the same town, may show considerable difference in the percentages of cattle affected with worm nodules. For instance, in the Upper North Coast District, at Bangalow, 4.9 per cent. of cows were affected, whereas at Ballina there were 41 per cent.; again, in the New England District, at Glen Innes, we have 2.2 per cent.; at Tenterfield, 5.5 per cent.; and at Inverell, 41.6 per cent. Then, again, at Junee we have 3.2 per cent., and at Albury, 22.4 per cent.

TABULATION OF RESULTS.

District.	Number of Cows examined.	Number with Worm-nests.	Number locally bred with Worm-nests.	Number of Nests.	Percentage affected.	Nests per affected Cows.
UPPER NORTH COAST.						
Murwillumbah	49	7	7	23	14·3	3·3
Bangalow	41	2	2	5	4·9	2·5
Ballina	75	31	31	81	41	2·6
Lismore	55	13	11	32	23·6	2·4
Casino	20	3	3	3	15	1
Mallanganee	83	24	24	37+	29	1·5
	323	80	78	181+	24·7	2·2

TABULATION OF RESULTS—*continued.*

District.	Number of Cows examined.	Number with Worm-nests.	Number locally with Worm-nests.	Number of Nests.	Percentage affected.	Nests per affected Cows.
MIDDLE NORTH COAST.						
North Dorrigo	22	3	3	4	13·6	1·3
HUNTER AND MANNING.						
Northern Coastal.						
Kendall	39	30	30	71	76·9	2·3
Western.						
Scone	32	6	6	9	18·7	1·5
	71	36	36	80	50·7	2·2
SOUTH COAST.						
Illawarra.						
Thirroul	26	1	1	1	3·8	1
Wollongong	60	10	9	14	16·6	1·4
Berry	35	3	2 (?)	3	8·5	1
	121	14	12 (?)	18	11·09	1·2
NORTHERN TABLELAND.						
New England.						
Tenterfield	54	3	..	5	5·5	1·6
Glen Innes	44	1	1	1	2·2	1
Inverell	48	20	20	28	41·6	1·4
Armidale	58	8	8	9	13·8	1·1
	204	32	29	43	15·6	1·3
CENTRAL TABLELANDS.						
Mudgee	94	35	33	45	37·2	1·2
Oberon	19	..	..	..	..	..
Bathurst	35	..	..	..	..	..
Blayney	42	..	..	..	..	..
Orange	46	7	6	..	15·2	..
Cowra	15	6	..	15 (?)	40	2·5
	251	48	39	60	19·1	·8
SOUTHERN TABLELANDS.						
Cooma	24	1	..	1	4·1	1
Queanbeyan	44	2	2	2	4·5	1
Goulburn	85	4	3	4	4·7	1
Yass	23	1	1	1	4·3	1
	176	8	6	8	3·4	1
NORTH-WESTERN SLOPE.						
Tamworth	74	40	37	69	54	1·7
Boggabri	5	3	1 (?)	3	60	1
	79	43	38	72	54·4	1·6
CENTRAL-WESTERN SLOPE.						
Dubbo	35	11	10	12	31·4	1·1
SOUTH-WESTERN SLOPE.						
Temora	36	3 (5?)	2 (?)	8	8·3	2·6
Junee	31	1	..	1	3·2	1
Wagga	27	1	1	1	3·7	1
Albury	49	11	4	14	22·4	1·3
	113	16 (?)	7 (?)	24	11·1	1·5
NORTH-WESTERN PLAINS.						
Moree	40	18	6+(?)	38	45	2·1
Narrabri	63	35	23+(?)	74	55·4	2·1
	103	53	29+(?)	112	51·4	2·1
CENTRAL-WESTERN PLAINS.						
Warren	2	1	1	5	50	5
RIVERINA.						
Narrandera	46	5	5 (?)	7	10·8	1·4
Leeton	42	4	3	5	9·5	1·2
Hay	30	2	..	4	6·6	2
Deniliquin	53	3	(?)	3	5·6	1
Finley	29	..	..	..	..	..
Berrigan	9	..	..	..	..	..
Corowa	28	4	..	5	14·3	1·2
Culcairn	37	2	2	2	5·7	1
	274	20	10 (?)	26	7·2	1·3

(a) Places with no worm nests :—
Central Tablelands—Oberon, Bathurst, Blayney.
Riverina—Finley, Berrigan.

(b) Places with under 10 per cent. of cows showing the presence of worm nests by manual palpation :—
Upper North Coast—Bangalow.
South Coast, Illawarra—Thirroul, Berry.
Northern Tableland, New England—Tenterfield, Glen Innes.
Southern Tablelands—Cooma, Queanbeyan, Goulburn, Yass.
South-Western Slope—Temora, Junee, Wagga.
Riverina—Leeton, Hay, Deniliquin, Culcairn.

(c) Places with 10 to 20 per cent. infestation :—
Upper North Coast—Murwillumbah, Casino.
Middle North Coast—North Dorrigo.
Hunter and Manning, Western—Scone.
South Coast, Illawarra—Wollongong.
Northern Tableland, New England—Armidale.
Central Tablelands—Orange.
Riverina—Narrandera (10·8 per cent.), Corowa.

(d) Places with 20 to 30 per cent. infestation :—
Upper North Coast—Lismore, Mallanganee (29 per cent.).
South-Western Slope—Albury.

(e) Places with 30 to 40 per cent. infestation :—
Upper North Coast—Ballina.
Northern Tableland, New England—Inverell.
North-Western Plains—Moree.

(f) Places with 50 to 60 per cent. infestation :—
North-Western Slope—Tamworth, Boggabri.
North-Western Plains—Narrabri.

(g) Places with 70 to 80 per cent. infestation :—
Hunter and Manning. Northern Coastal—Kendall (76·9 per cent.).

SUMMARY.

High, cold (in winter), poorly-timbered country shows an absence of worm nests (*e.g.*, Oberon, Bathurst, Blayney), or a small percentage of cows affected (*e.g.*, Tenterfield and Glen Innes, and Southern Tablelands). The coastal districts, both north and south, show wide variations, but in general higher infestations have been found on the north coast than on the south, whilst the highest infestation met with anywhere, namely, 76.9 per cent., was found at Kendall. It is remarkable that whilst Bangalow shows only 4.9 per cent., Ballina, in the same district, shows 41 per cent. In some cases the presence of heavy timber and creeks in proximity to dairies seems to favour infestation. The dry western type of country shows heavy infestation in such places as Moree, Narrabri, Dubbo, and Mudgee. Somewhat higher and cooler climates of similar character may also yield high infestations, as at Inverell and Tamworth. When these same types of country are examined further south, infestation is in general much less; thus, on the south-western slopes, the infestation is under 10 per cent., except at Albury, where it was 22.4 per cent.; in the Riverina two towns showed an absence of worm nests, four had under 10 per cent. of infestation, Narrandera 10.8, and Corowa 14.3 per cent. It would, therefore, appear that the dry western type of country, whether on the slopes or the inland plains, and the moister coastal climate, both offer better facilities for worm-nest infestation in the north of the State than in the south. To a certain extent the southern parts of these districts are cooler than the northern. Another explanation may possibly be in the distribution of the rainfall, summer rains being experienced in the northern part of the State, and winter rains in the southern.

Personal.

The Hon. W. Massy Greene, M.P., whose portrait appears in this issue, is Ministerial head of the Institute of Science and Industry. Although his Parliamentary career has not been a particularly long one, he having entered politics as member for Richmond (New South Wales) at the general election in 1910, he has already been called upon to fill several important positions. Prior to assuming ministerial office he acted, with conspicuous success, as whip to the Liberal Opposition, becoming later a strong supporter of the Hughes-Cook National coalition. In March, 1918, he was made an assistant minister, specially in charge of matters relating to price-fixing. The same year he was appointed a member of the Board of Trade, and in January of this year gained full ministerial rank, being given the portfolio of Minister for Trade and Customs.

Mr. Massy Greene's personal interests are centered in the advancement of rural industries. Driven to the country in search of health, after a few years' experience of a banking institution, he settled in the north coast of New South Wales. There he had literally to carve a home for himself out of the virgin forest, but his labours were rewarded by the enhancement of the value of the land, and the speedy development of the district into one of the most prosperous dairying centres in Australia. His intimate knowledge of the dairying industry has made him a strong advocate of the more efficient organization of producers. He recently outlined a scheme aiming at the co-operative control of dairy produce upon a Federal basis which would improve the position of the dairy farmers, and induce the expansion of an industry whose ultimate value to Australia cannot yet be estimated. That scheme is now under the consideration of the dairy farmers of Australia. That portion of the work of the Institute which has special application to rural interests always finds in Mr. Greene a keen though sympathetic critic.

For some time Mr. Edward S. Simpson, of the Geological Department, Perth, Western Australia, has been doing valuable work for the Institute in connexion with clay investigations. At the annual commencement of the University of Western Australia recently, the degree of Doctor of Science was conferred on Mr. Simpson. Dr. Simpson was educated at the Sydney Grammar School, and after a distinguished career at the University of Sydney, where he was one of the first to obtain the degree of Bachelor of Engineering, received an appointment on the staff of the Mount Morgan G. M. Company, Queensland. In 1897 he was appointed assayer and mineralogist to the Geological Survey of Western Australia, and has held that position ever since. He has spent much time on original research work in connexion with the many rarer minerals which from time to time have been found in the Western State, and is recognised as an authority on these matters, not only all over the Commonwealth, but also in many of the older countries of the world. Much of his time lately has been occupied with economic mineralogy, and his success in this direction has been instrumental in establishing some most important industries in and around Perth.

Professor Gibson, who was the first chairman of the Queensland Committee of the Advisory Council, recently had the degree of Master of Engineering conferred upon him by the Senate of the Brisbane University. Sir Pope Cooper, who presided, stated that the professor had commenced his engineering career in the Thames Iron and Steel Works, England. From there he had travelled to China, where he became engaged in a shipping company. He was not suffered to remain in peace for long, however, and when the Boxer insurrection broke out he volunteered for service. His performance in that direction was admirable, and in consequence was awarded a medal. It was in the latter part of the year 1900 that he came to Australia, entering the Public Service of New South Wales in the beginning of 1901. His work attracted the attention of the Sydney University, and not long after he accepted the position of P. N. Russell Lecturer of Engineering Designs there. In 1909 he came to the Brisbane University, where he continued his excellent work until he was called upon to do another great service for his country as official censor. This was a business which required brains, loyalty, and the ability of keeping things absolutely secret from all—a hard matter for many people. This work he carried out with unusual skill, till, at length, he abandoned it for munition work in Melbourne. At one time Professor Gibson had under his control over 5,000 Australian munition workers, and participated in the formation of the first Australian arsenal. In conferring the degree, the president said that the honour not only lay with the professor, but also with his associates and fellow workers. Professor Gibson did excellent work as a member of the Executive Committee of the Advisory Council while resident in Melbourne on military duties.

Mr. A. Male has been appointed Deputy Chairman of the Tick Eradication Committee (Western Australia) during the absence of Mr. C. Nathan in the United States. Mr. W. B. Alexander, M.A., has been added to the committee.

Mr. R. C. Callister has been appointed chemist to the White Earthenware Committee at Ballarat. He recently returned from service with the Australian Imperial Force.

Mr. W. Miller, who is a member of the White Earthenware Committee appointed by the Institute of Science and Industry, left for the United States early this month. He intends to make inquiries on behalf of the Institute into a number of matters affecting the manufacture of pottery.

Another visitor to the United States at an early date will be Mr. Gilbert Rigg, of the Broken Hill Associated Smelters Proprietary Limited. Mr. Rigg has for many years interested himself in the question of standardization, and he will inquire on behalf of the Institute into the organization of the Bureau of Standards at Washington, and collect such other information as is likely to prove advantageous to the commencement of similar work in Australia.

Mr. Gerald Lightfoot, the Secretary of the Institute, has been successfully operated on for appendicitis, and will shortly resume his duties.

PERSONAL.

Mr. Bagster has just about completed his investigations into an effective method of decolourization of leather tanned by mangrove bark, and his report will soon be issued.

Mr. C. E. Lane Poole, who has been Conservator of Forests in Western Australia for some years, and a member of the Advisory Council of Science and Industry, has been appointed one of the Victorian Forest Commissioners, at a salary of £800 a year.

Professor H. C. Richards, of Brisbane, has been recommended as a full member of the Advisory Council of Science and Industry. He has been an associate member from the first, and has done excellent work as Honorary Secretary of the Queensland State Committee.

Dr. H. G. Chapman is still working on his bread-making experiments, and is very satisfied with the results.

Professor Douglas Stewart hopes to visit Western Australia in connexion with tick eradication during the long vacation.

Mr. D. Avery, of Avery and Anderson, consulting chemists, has been added to the special committee which is carrying out investigations into fuel economy.

Mr. E. E. Turner, M.Sc. (Lond.), B.A. (Camb.), A.I.C., has been appointed additional lecturer and demonstrator in the Organic Chemistry Department of the University of Sydney.

Status of the Chemist: His Relation to Manufacture.

By BERTRAM BLOUNT.

I happen to know Germany fairly well, having been there more times than I can count, and having conferred with German chemists and manufacturers on many occasions and on many technical subjects, and I can safely say that in that country the right of a man trained as a chemist to control of works depending for its existence and vitality on chemical science is fully recognised.

What is the result? The highly-trained young man enters a large business establishment, not as a chemical hack, but on much the same terms as a junior partner on the commercial side, and, as he grows in experience and standing, will delegate this routine chemical work to other young men, just as the ordinary rising business man deputes his work to his manager and clerks. From the start he not only ranks equally with his commercial colleagues, but, having special knowledge of the basis on which their joint business rests, he naturally becomes its head, as I have seen again and again in Germany, but rarely here.

Now, the position in this country is all wrong, and until it is righted we might as well reconcile ourselves to the old blundering methods most properly condemned by Sir Gerard Muntz. It must be remedied by a closer co-operation between the manufacturer, the practical chemist, and the pure scientist. All three can contribute, and the immediate need is collaboration between the practical chemist and the manufacturer.

The kind of chemist I mean is one who has been accustomed to deal with the practical needs of manufacturers, who, while entirely *au fait* with laboratory procedure, is completely at home in a works, and can think as easily in tons and cubic feet as he can in milligrammes and cubic centimètres. Above all, he must have a sense of proportion, and be able to realize without effort that an error which would be fatal in a laboratory operation may be insignificant in a manufacturing operation, and be equally able to comprehend that some small difference of condition scarcely appreciable on a small scale may have a dominant and deciding effect when on a large scale it is translated into terms of money.

I must revert to the mistake often made by manufacturers when they wish the guidance of the chemist. Quite apart from the notion that he is often regarded as a mere hack or tester, the view that he is a person whose advice can be obtained at nominal fees is ludicrously prevalent, and coupled with this is the bizarre and touching faith that by putting something into a test tube, then into another test tube, and adding something called "a chemical," the most difficult industrial problems can be solved in about a quarter of an hour.

May I give the gravest warning to all who cherish this belief? If they persist in holding it, our chemical pre-eminence dating from Elizabethan times to the beginning of the nineteenth century—from Bacon and Boyle to Davy—will never return. In the time of Charles II. it was the sign of a finished gentleman to be an accomplished chemist, and in this more commercial age the consulting chemist must take his place on the same plane as the consulting physician or surgeon, and must be rewarded for his highly skilled work on the same scale.

At the beginning of the war certain noted persons were appointed at handsome fees to give medical and surgical advice to the Government. No sensible man can possibly object to this. The cost is a trifle compared with that of the general conduct of the war. I do not find, however, that any corresponding posts at corresponding fees were allotted to chemists whose position was at least as high and whose national value was at least as great. This kind of thing is obsolete, and must cease.

Analyzing the causes of a difficult and dangerous situation, I have come to the opinion that the *fons et origo mali* is the curious educational system in force here. In Germany no man who claims to be decently educated is ignorant of elementary science; here his ignorance is so profound that he does not know why carbon burns and quartz does not. Yet what would he say to a chemist who could not translate a common tag—for example, *rem tetigisti acer*, or the other tag which I have written above? Which of our present race of lawyer-politicians can write an intelligible letter even in mediæval Latin? Which of those who went to Paris to confer with the French Government can speak decent colloquial French, or could, if put to it, translate accurately and without a dictionary a German legal document such as a patent specification? These are trifling accomplishments, and I mention them merely to show that it is useless to contend that neglect of science is justified by literary acquirements.

To put the whole matter in the shortest terms: This nation has to learn to respect science, to learn all it can of it, to understand the difference between purely academical knowledge and the knowledge acquired in practice, and to choose its rulers from those trained in physical science and not from the ranks of the rhetorician, dialectician, and least of all from that of the lawyer politician.

Rabbit Myxoma.

Interest attaches to a letter received by Mr. F. H. Taylor, Entomologist to the Institute in Queensland, from Dr. Aragao, Assistant at the Institute Oswald Cruz, Rio de Janeiro, regarding a disease known

RABBITS INFECTED WITH MYXOMA.

as rabbit myxoma. Dr. Aragao writes that he has successfully infected rabbits with myxoma, and suggests that the utilization of the virus

might be followed by good results in Australia. The disease, he maintains, attacks rabbits exclusively, and is of common occurrence in Rio. When an epidemic occurs, the mortality among rabbits ranges from 90 to 100 per cent. The accompanying photographs illustrate the nature of the disease, the final stage of which is marked by the appearance of tumours on the nose, ears, and body of the animal. A report of the experimental work carried out by Dr. Aragao was sent to Dr. Breinl, Director of the Institute of Tropical Medicine at Townsville, but it had not been received at the time of publication of this journal.

Calcium Carbide.

CORRELATED INDUSTRIES.

The following memorandum has been prepared at the request of the Commonwealth Board of Trade by the Chemicals Committee of the Institute on the above subject:—

1. Following on the discovery by Willson in America of the commercial production of calcium carbide about twenty-five years ago, it is common knowledge that its use for generating acetylene for lighting purposes rapidly grew to enormous dimensions.

For some time this was its sole value, but of recent years other processes have been developed which are becoming of more and more importance as the earlier difficulties are being overcome and more economical factory methods devised.

2. Although the use of acetylene as an illuminant is being gradually replaced by the introduction of electrical lighting systems, particularly for motor cars, motor cycles, and country houses, this has been more than compensated for by the discovery that its high heat of combustion can be usefully applied for welding and cutting iron and steel. This application is making enormous strides in many industries, and is specially adapted to repair and construction work in machinery shops.

3. The most important development has, however, been in the use of calcium carbide as a "key chemical" from which other compounds may be manufactured by various chemical processes.

The first of these depends on the combination of the carbide with atmospheric nitrogen at a high temperature to form calcium cyanamide or nitrolim. This has found considerable application in Europe as an agricultural fertilizer, as when it comes in contact with the moisture of the soil it gradually becomes converted into ammonium salts, and finally into nitrates. The reaction may be checked under suitable conditions at the intermediate stage, and, by treating it with superheated steam, cyanamide is so used for the manufacture of ammonia itself. Among other products of cyanamide may be mentioned dicyandiamide, used in explosives, and a mixture of cyanides suitable for gold extraction.

4. Another development of even more far-reaching importance is the conversion of acetylene into alcohol. This synthetic manufacture of alcohol is being carried out on a large scale in Switzerland and America, where cheap water-power is available, with such success that it has been said that this process will in the future replace the present methods of producing alcohol.

Such a cheap source of alcohol will undoubtedly be utilized for making acetone and other chemicals, as well as the innumerable other purposes for which it has been indispensable in the past. It is, of course, impossible to forecast the extent of the demand for acetylene-made alcohol, because this will depend on its price.

Cheap alcohol (1s. 6d. to 2s. a gallon), besides largely ousting petrol as a fuel, would revolutionize many industries dealing with dyestuffs and other organic chemicals.

There is no doubt that several of these manufactures, at present non-existent or practically so in Australia, would be conducted on a large scale had they this advantage.

CALCIUM CARBIDE: CORRELATED INDUSTRIES.

5. The above (which are also indicated in the diagram appended) are probably the chief outlets for a large supply of Australian-manufactured calcium carbide; or, rather, these are the technical industries that have grown up in the very few years that have elapsed since cheap acetylene has been a commercial fact, but it must be borne in mind that further developments at least equal to these may be expected during the next twenty years.

The importance of these industries is well illustrated by the accounts that have been published of the carbide works at Odda, Norway, where the output of carbide amounted to about 50,000 tons in 1914, with the expectation of a considerable increase.

Any encouragement that can be given to this manufacture may be expected also to react on the correlated industries mentioned in this memorandum.

CHART OF THE CALCIUM CARBIDE INDUSTRY.

- Calcium carbide
  - Acetylene
    - for lighting
      - used direct
      - stored as a solution in acetone
    - for heating
      - welding iron and steel
      - cutting iron and steel
    - for power
      - used as fuel in explosion motors
    - as a chemical to make
      - alcohol
        - for power
        - for making acetone
        - for use in many chemical processes
      - fine chemicals
  - Cyanamide
    - as an agricultural fertilizer
    - ammonia and ammonium salts
    - cyanide for gold extraction
    - dicyandiamide for toning down explosives.

In conclusion, it should be mentioned that in Tasmania the erection of a plant for the manufacture of calcium carbide has been completed, with the exception of the necessary electrodes. As soon as these are available, either from abroad or of local manufacture, carbide will be manufactured at the rate of 100 tons per week.

Clearly we can have no research work without competent research workers. And in the absence of any earlier organized effort in this direction, we must look to the rising generation to supply our present needs. Hence the prime necessity, not only of fostering a love of research in young students, with good natural aptitude, but, in addition, of placing within their reach the means of taking up any line of work which happened to appeal to them.

—*Professor A. J. PERKINS.*

REVIEWS.

Powdered Coal as a Fuel, by C. F. Herington. New York. D. Van Nostrand Co., 1918.—This informative book, which deals comprehensively with a subject attracting an increasing amount of attention, describes the various patents, designs, and systems now in use in the United States. The main chapters of the book are devoted respectively to the preparation, feeding, and burning of powdered coal, and to its use in the cement industry, in reverberatory furnaces, in metallurgical furnaces, under boilers, and for locomotives. Powdered coal was first used on an industrial scale 44 years ago in the United States in cement furnaces, and at the present time fully 90 per cent. of the Portland cement made in that country is burned in kilns using powdered coal. In former years, oil fuel was used in the cement industry, but the increase in price of oil after 1895 made the use of that fuel almost impracticable commercially. This was the principle incentive for developing the use of powdered coal, which is specially suitable for the high temperatures required for the chemical combinations in the manufacture of cement.

By ordinary manipulation in the use of powdered coal, the temperature and quantity of fire can be changed as easily as a gas jet can be turned on or off. The response is instantaneous, and it is this particular feature which renders the use of pulverized fuel particularly suitable for metallurgical furnaces. Powdered coal is used in all kinds of steel and iron working, including ore-roasting, and in open-hearth furnaces, puddling furnaces, and pig furnaces. The present consumption of powdered coal in the United States is over 8,000,000 tons annually.

The author states that the necessity for insuring supplies of oil fuel will soon eliminate it from railway motive power use. Though but little actual operating data are available, it appears that powdered fuel has special advantages for locomotives by reason of its dependability, flexibility, effectiveness, and economy, and its ability to meet public demands for the reduction of smoke, soot, cinders, and work. The book is well indexed. It contains a valuable bibliography, and is admirably illustrated.

The Prickly Pear in Australia, by W. B. Alexander, M.A. This is a bulletin (No. 12) just issued by the Institute of Science and Industry. It deals with one of the greatest obstacles which impedes pastoral and agricultural progress over a large portion of the Commonwealth. The magnitude of the problems connected with the eradication of the prickly pear is disclosed by the fact that an area of over 20,000,000 acres is infested in Queensland, and an area of over 2,200,000 acres in New South Wales. The rate of increase of the pest is estimated at 1,000,000 acres per annum. No discrimination is shown in the land that is attacked. Rich country is as quickly overcome as poor country, and in a short time is rendered unproductive and valueless.

Owing to its tenacity of life, its armature of prickles and spines, and its succulent nature, the prickly pear plant is extremely difficult to eradicate. The cost of eradicating pear by manual labour from land thickly infested is prohibitive, except where the land is exceptionally valuable, and in consequence

many methods have been suggested whereby the cost might be reduced. These suggested methods fall into two groups—

1. Those in which it is proposed to find commercial uses for the pear and thereby pay the whole or part of the cost of clearing the pear-infested land.
2. Those in which it is proposed to utilize special machinery, poisons, or natural enemies to destroy the pear.

Of the great number of ways suggested for utilizing the pear, the only one which has proved satisfactory is that of feeding it to stock. By the addition of various additional feeding stuffs satisfactory rations for cattle and "dry" sheep, consisting chiefly of prickly pear, can be provided. Breeding ewes and lambs, however, do not do well on pear. If all the cattle in Australia were fed entirely on prickly pear it is doubtful whether they would be able to keep pace with its annual increase alone, hence as a means of eradicating the pest from Australia its utilization for stock is not very helpful.

The manufacture from prickly pear of alcohol, paper or cardboard, potash, and various other materials has been suggested, but in all these cases the fact that prickly pear consists very largely of water makes its profitable commercial utilization very unlikely.

No satisfactory machine for destroying prickly pear has yet been invented, and the problem, owing to the bulk of the material, is a very difficult one.

Greater success has been achieved in the search for poisons, and as a result of a very large number of tests it has been established that compounds of arsenic are the most useful poisons, being specially toxic to prickly pears. Arsenic acid is the most deadly compound for use in solution as a spray or by injection, but, unfortunately, it is practically unobtainable in Australia. Arsenious chloride is at present the chemical chiefly in use, and is applied either as a spray or in the form of gas where the pear is impenetrable. Arsenate of soda, being cheaper and less dangerous to handle, is still used to some extent, but necessitates the use of large quantities of water in making solutions, and at least two sprayings are required to kill the pear.

Mechanical or chemical treatment necessitates continuous work of some kind for keeping the land clear The only method which has been suggested whereby the plant might ultimately be destroyed is by the employment of natural enemies, and it is only by the introduction of such enemies that even the land which is now clear can be considered safe from further serious infestation. A large number of kinds of insects are known which feed exclusively on one or more kinds of prickly pear, and in the absence of pear cannot survive. The only insects of this type yet introduced to Australia are certain wild cochineal insects which feed on the so-called tree pear (*Opuntia monocantha*), and in a few years they practically exterminated this variety of opuntia. It is hoped that the Institute of Science and Industry will be able shortly to take up this work. The Institute recently issued a bulletin (No. 12) dealing with this subject, which was prepared by Mr. W. B. Alexander, M.A.

Asphalts and Allied Substances, by Herbert Abraham, B.Sc., D. Van Nostrand Co., New York, 1918. This treatise has been prepared for those interested in the fabrication, merchandising, and application of bituminous products, and embraces—(1) methods serving as a guide for the works chemist engaged in testing and analyzing raw and manufactured products; (2) data for assisting the refinery or factory superintendent in blending and compounding mixtures; (3) information enabling the ambitious salesman to enlarge his knowledge concerning the scope and limitations of the articles he needs; and (4) the principles underlying the practical application of bituminous products for structural purposes, of interest to the engineer, contractor, and architect. Subject-matter of sole value to the technical man has been segregated under the heading, "Methods of Testing," excepting an outline of the "Chemistry of Bituminous Substances."

The earlier chapters comprise an historical and geological review of the use and origin of bitumens and pyrobitumens, and the methods of refining. The section dealing with tars and pitches records the advances made in recent years

in distillation processes. About 78 per cent. of the coal tar produced annually in the United States is obtained from coke ovens equipped to recover by-products. This, however, only represents between 40 and 50 per cent. of the total quantity of bituminous coal converted into coke. The remaining 50 or 60 per cent. is coked in brick "beehive" ovens not adapted to recover the gas, ammonia, or tar, thus constituting a waste running into many millions of dollars annually. The tendency, in the United States, however, is to replace these ovens with types adapted to recover the by-products. The comparative cheapness of bituminous coal in America, and the low price commanded by the products, has been responsible for the wastage; but changed economic conditions are bringing American practice close to the practice of some European countries.

Mr. Abraham explains that, in view of the vast amount of ground covered in the volume, he took it upon himself to draw freely from contemporary text-books and journal articles. The enormous number of references indicate the author's industry, and adds to its value. Nevertheless, there is included a substantial amount of original data accumulated by the author during the past nineteen years, most of which, he states, appears in print for the first time.

If science is to come by its own the nation as a whole must be brought to recognise the fundamental importance of the facts and principles of science to the right ordering of our national life. The more closely the work of our legislators touches the life of the people the more intimately it is concerned with questions of food supply, housing, &c., the utilization of natural resources and the conditions making bodily health, the more dependent it becomes on the skilled advice and assistance of those who can bring this knowledge of science to bear on social and economic problems.

—*Report of Committee appointed by the British Prime Minister to inquire into the position occupied by Natural Science in the Educational System of Great Britain.*

Mr. H. W. CEPP, an Industrial Leader and a Member of the Executive Committee of Science and Industry

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

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The Institute's Bill.

THE Bill to clothe the Institute with statutory sanction is now on the business-paper of the Federal Legislature. This being so, some brief commentary upon the principles involved in the measure may not prove inopportune. The Institute is essentially an activity of the Commonwealth Government. It operates under a Minister who is responsible to Parliament, and it looks to Parliament for such annual appropriations as may be necessary for the efficient discharge of its functions. All this is very clear. At the same time, the Institute is to be something more than a mere Government Department. It is proposed to make it a body corporate, with perpetual succession and a common seal, and capable of sueing and being sued. It will have power to hold lands and other property, or may accept gifts or become a beneficiary under a will. These provisions differentiate it from ordinary governmental departments. The object is clearly to encourage wealthy citizens of the Commonwealth to endow the Institute, either by gifts of land or money during their lifetime, or by making provision for it after their death. Those who drafted the measure evidently had in their minds the handsome bequests that certain institutions of this character in the United States have received from patriotic Americans desirous of seeing their names perpetuated through the centuries. The pork butcher of Chicago rendered his name imperishable by endowing some scientific or learned institute with a new library or a much-needed laboratory. So it is hoped that the wealthy

pastoralists, mine-owners, or merchant princes of Australia will show their appreciation of the land from which their wealth has been derived by helping present and future generations to render themselves more efficient antagonists in the economic struggles to come. It is to make the way easy for the handling of these prospective endowments that these provisions in the Bill are being made. The pious hope may be expressed that these clauses may not prove a dead letter, and that those Australians who have waxed prosperous in this fair and fruitful land will not be neglectful of their obligations to generations yet unborn.

The work of the Institute will be controlled by three directors, two of whom must have scientific training. Their salaries shall be determined by the Governor-General, that is, the Executive, and their term of office shall be five years, after which they will be eligible for re-appointment. This gives the directors a certain measure of independence, which, lest it might be carried to extremes, is qualified by the power given to the Minister to suspend a director for "incapacity, incompetence, or misbehaviour." To avoid the possibility of such power being used arbitrarily, there is a provision that in the event of a director being so suspended, the Governor-General may appoint a Board of Inquiry to investigate and report upon the case. In no other way may a director be removed from office during the statutory term. The directors, on their part, are compelled to give their whole time to the business of the Institute, and are prohibited from holding the office of director of a company.

To assist the directors, and to insure that the needs of each of the far-flung States of the Commonwealth may not be overlooked, it is provided that there shall be an advisory council in each State, the members of which may be paid fees for attendance, as well as out-of-pocket travelling expenses when called away from home in connexion with the business of the Institute. To make it quite certain that these advisory councils shall not have their functions whittled away, one or more of the directors is compelled to meet and confer with each advisory council at least once a year.

Under the constitution, certain functions can and certain other functions cannot be carried out by the Commonwealth Government, so, under the Bill, it is provided that certain powers may be exercised by the directors directly, while other powers may only be exercised after an agreement has been entered into between the Governor-General and the Governor of one or more of the States. As an example of a power which is constitutionally beyond the competence of the Institute may be instanced the power to teach science in the schools or universities. Education is clearly a function constitutionally reserved to the States. At the same time, it was apparently thought by those who drafted the Bill that

some aid might with advantage be given to scientific education, hence power to do so is being asked for, subject to the limitation that it can be exercised only after agreement with the States. We thus find that the powers and functions of the directors are divided into two groups. The first and most important group of powers which the directors may exercise, subject only to the regulations and the consent of the Minister, may be set out as follow:—

(*a*) the initiation and carrying out of scientific researches in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth;

(*b*) the establishment and awarding of industrial research, studentships, and fellowships;

(*c*) the making of grants in aid of pure scientific research;

(*d*) the recognition or establishment of associations of persons engaged in any industry or industries for the purpose of carrying out industrial scientific research, and the co-operation with and the making of grants to such associations when recognised or established;

(*e*) the testing and standardization of scientific apparatus and instruments, and of apparatus, machinery, materials, and instruments used in industry;

(*f*) the establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters; and

(*g*) the collection and dissemination of information regarding industrial welfare, and questions relating to the improvement of industrial conditions.

Another group of functions which can only be exercised after agreement between the States and the Commonwealth, and formally finalized by correspondence between the Governor-General and the Governor of one, or more of the States concerned, may be set out as follow:—

(*a*) the utilization for the purposes of this Act of State Research Departments and laboratories, and experimental stations and farms;

(*b*) the co-operation in industrial and scientific research with State Government Departments, universities, and technical schools; and

(*c*) the co-operation with educational authorities and scientific societies in the Commonwealth with a view to—

(i) advancing the teaching of science in schools, technical colleges, and universities where the teaching is determined by those authorities;

(ii) the training of investigators in pure and applied science and of technical experts; and

(iii) the training and education of craftsmen and skilled artisans.

Among minor provisions is one which removes officers of the Institute from the operations of the Commonwealth Public Service Act. The object here is to secure greater efficiency by throwing the whole responsibility for the staff upon the shoulders of the directors, and so preventing them, in the case of failure, from being in a position to urge that the real responsibility did not rest upon themselves, but upon the Public Service Commissioner, who selected their staff. Another difficulty to be overcome was the necessity for, in some way or other, freeing purely scientific workers from the rigid regulations of the Public Service Act, which, when framed, did not contemplate the appointment of professional men of this kind. Another section provides that whenever a discovery of any value is made by an officer of the Institute, such discovery is to be vested in the Institute, and become its sole property. At the same time, power is asked to enable the directors to grant any fee or reward that may be desirable to more fully compensate such officer whose brains have been exploited for the benefit of the community.

Most of the work done by the Institute and carried out by the aid of public funds will immediately become public property. At the same time, the Institute is not precluded from carrying out investigational work on behalf of any individual, firm, or company, at its request. Where such work is done, however, it shall be done, not at the expense of the community, but at the expense of the person benefiting. Such are the proposed statutory powers of the Institute of Science and Industry.

—F. M. G.

Science moves but slowly, slowly creeping on from point to point.

—*Tennyson.*

EDITORIAL

STANDARDIZATION OF RAILWAY RAILS.

A further stage in the huge and difficult task of the standardization of engineering practice in Australia has been taken by the Institute of Science and Industry by the convention of a Conference to draw up specifications for railway rails and fish-plates. Much of the preliminary work had been accomplished by the engineers of the Commonwealth and State Railway Departments, who had already agreed upon the standards for steel rails; but considerable work remained to be done in the adoption of specifications which would conform to the requirements of the Railway Departments, and which would assist Australian manufacturers against the keen competition of other countries. Despite the complexities of the problem, success has been attained, and an agreement, which was unanimously adopted by the delegates, now only awaits the ratification of the various Governments of the Commonwealth. The Conference was held at the Institute of Science and Industry, Melbourne, on 30th July and 31st July, and 1st August, under the direction of Professor T. R. Lyle, and was attended by Messrs. R. Kendall (Engineer-in-Chief for Existing Lines, New South Wales), E. H. Ballard (Chief Engineer for Ways and Works, Victoria), M. E. Kernot (Chief Engineer for Railway Construction, Victoria), J. C. B. Moncrieff (Chief Engineer for Railways, South Australia), W. J. N. Short (Commonwealth Railways), C. Hoskins (G. and C. Hoskins Proprietary Limited); and Messrs. E. Lewis, L. Bradford, and R. H. M. Rowe (Broken Hill Proprietary Limited). The Western Australian Government was represented by Mr. Ballard; but Queensland, at the last moment, found it impossible to send a delegate. The value of railway rails used in Australia annually at present prices is, approximately, £2,000,000, and of fish-plates, £150,000. The direct result of the action of the Institute in enabling the users and the manufacturers to meet and discuss the various aspects of standardization, and the valuable assistance rendered by Professor Lyle in effecting a compromise upon the more contentious technical points, will be to give the Commonwealth an opportunity of competing more favorably for the large volume of trade which previously went to overseas corporations. The decisions arrived at by the Conference on structural steel sections will exert a similarly useful purpose, and must be reflected by a considerable accession of business to local manufacturers. Where the difficulties, owing to the apparently irreconcilable opinions of many of the interested parties appeared so great, it speaks well for the spirit which actuated the representatives who met together, and augurs well for the success of future efforts.

AN AUSTRALIAN INDUSTRIAL LABORATORY.

In a recent issue of the *Australasian Manufacturer,* we note with pleasure an article on "Industrial and Chemical Research Work," and the announcement of the establishment of extensive well-equipped laboratories for the firm of F. A. Henriques, Limited, Sydney. The illustrations indicate the extensive nature of the investigations which the firm is prepared to undertake, not only on its own behalf, but in the interests of all engaged in industrial chemistry. The company has erected models of actual manufacturing plants, covering the more usual operations of mixing, heating in various ways, evaporating (normal or *in vacuo*), drying by hot blast, filtering (press), centrifugal extracting and smelting, &c., where processes can be tested on a larger scale than in the analytical laboratory, thus preventing disappointment on taking up immature, but hopeful, processes and inventions.

The illustrations give some indication that provision is made for examinations demanding the use of the microscope, polariscope, and spectroscope. Australia is exceptionally backward in the use of such instruments in applied scientific work. The extent to which they are now used, together with many modified photographic processes, and the ease, accuracy, and rapidity with which many determinations are made, demand that any institution that claims to be able to engage in such branches of work as organic and inorganic chemical analysis, the examination of food and drugs, leather and paper, cements and ceramics, pigments and paints, as well as the investigations of many metallurgical processes, especially on alloys, must be adequately equipped with such apparatus, in charge of some one well qualified to use it. In Europe and United States of America it is possible to obtain certain instruction in such branches of work, which we might call industrial and chemical microscopy, and the introduction of some comprehensive course in our Australian institutions would be a step in advance.

We would like to emphasize one other subject with which we cordially agree, viz., the use of a reference library. A well-stocked and classified scientific library is one of the first and most pressing needs in such a research institution, and it must be kept up to date with all the trade, technical, and scientific journals, proceedings of learned societies, and monographs of scientific work, no matter in what language they may be printed.

PROPOSED DUTY ON SCIENTIFIC LITERATURE.

In response to representations made by the Executive Committee to the Minister for Trade and Customs regarding the imposition of a prohibitive duty on scientific publications containing advertisements, a letter was received from the Acting Comptroller-General pointing out that the Government did not contemplate the imposition of a duty that would affect the free introduction of scientific or other journals containing advertisements provided the object of such publications was not the advertisement of an individual business. It was added that no representations in favour of a duty of the kind suggested had been received in connexion with the revision of the tariff.

LEATHER STANDARDIZATION.

Some interesting facts were put before the Executive Committee of the Advisory Council last month by Mr. Marcus Bell, of the Commonwealth Arsenal, relative to the possibility of grading Australian leather. He pointed out that the standardization of sole leather would entail the standardization of methods of production; and the materials used, other than hide, would have to be well known. Mr. F. A. Coombs, of the Technical College, Sydney, had expressed doubt whether wattle bark could produce a good sole leather under normal conditions. It was to be assumed that by "normal" conditions, were meant good factory conditions, and that being the case, inquiry would first have to be made whether wattle bark could produce a satisfactory sole leather under any method whatsoever. If it could be shown that a satisfactory sole leather could be produced with wattle bark it would then be necessary to ascertain whether the leather could attain to a certain standard degree of wearing. These points would involve a laboratory test, and some actual test on the feet. One difficulty of standardizing such tests would be in the valuation of the samples. Good sole leather depended less obviously on the method of tanning than on the part of the hide from which the sole leather was cut, therefore it would be necessary to control the utilization of certain portions of the hide, and this might re-act against the small business man who soled boots with leather from any part of the hide. A wearing test would be difficult to apply. He knew of no specification which laid down the chemical property of leather, and to ascertain this it would be necessary to discover what amount of tannin, combined with a given proportion of hide substance, and the amount of water soluble extractives. Australian tanned sole leather had a proportion of tannin substance of from 50 per cent. to 55 per cent., as compared with 100 per cent. of hide substance. According to English and American authorities (Dr. Proctor, in the one case, and the Bureau of Chemistry in the other), good sole leather should combine 75 per cent. of tannin with 100 per cent. of hide substance. That estimate was based upon experiments with oak and hemlock, and might not apply to wattle bark. If a 70 per cent. to 75 per cent. figure were to be insisted upon for the Australian product a great deal more investigation would be necessary, and if grading of Australian sole leather were to be carried out in accordance with the expressed opinion of recognised authorities in other countries, no Australian sole leather which he had examined could be placed in a high grade because of the low proportion of combined tannin and the high proportion of water soluble constituents.

AUSTRALIAN AND ENGLISH LEATHER COMPARED.

Mr. Bell added that when it was suggested that the Defence Department should amend its specifications in order to raise the amount of tannin substance, it was then found that there would be no prospect of securing leather, as it could not be left long enough in the tan-pit. It would be necessary also, in grading leather, to get samples of the best leather that other countries could produce. He had obtained a sample of the best grade of imported English sole leather, which was about 1d. per lb. dearer than the best Australian, and if analysis were

to be accepted as a criterion, it was inferior to many Australian leathers. An English expert to whom that English sample had been submitted at once picked it out as the best leather—that was because he was attracted by the colour and the general appearance. It was not, however, superior to the bulk of the Australian sole leathers that were then being examined. He knew of no satisfactory laboratory test for comparing wearing qualities; he had, however, devised a rough and ready test. By attaching leather to a wheel and revolving it so that the leather acted as a brake-shoe, some interesting figures of the wearing value of sole leathers were obtained. Different samples would take from 4 to 30 minutes to wear through 1-10th inch. The English soles—taking the worst of the Australian soles as 1, were on the average about 3, while the Australian ranged from 2½ to 6. One sample had been known to go to 8. The chemical analyses of these were practically identical. A firm in Melbourne made the best sole leather, so far as he knew, and one sample of theirs under this test went to 8.5. They used wattle bark. Attempts he had made to obtain a first-class sole leather that was much better than the Australian article had failed, and he was by no means certain that the local stuff was so much inferior. Mr. Bell said that he knew of no system of grading in England—or anywhere else—but if grading were attempted here it would be essential to combine a knowledge of tanning with laboratory tests. Mr. Bell said that he had read both Mr. Coombs' and Mr. Anderson's reports on Australian leathers, and was more inclined to agree with the latter than the former. His opinion was that the best leather was not turned out in Australia, but that the quality could be greatly improved. He thought that Australian leather was susceptible of great improvement, and that if this improvement were made no better leather would be produced. It was generally recognised that a much longer time in the pits than was given in Australia would be a great advantage. Until that was tried, it was not, perhaps, worth while trying other things. Wattle bark should be thoroughly tested. On the test figures previously referred to the bulk of the Australian leather would be represented by 3.

UTILIZATION OF SPENT WATTLE BARK FOR PAPER MAKING.

On the outbreak of war the German market for wattle bark was closed, and the bark was placed on the English market. The Imperial Institute took the opportunity of again urging the British tanners to use larger quantities of wattle bark, or in its place, the concentrated tannin extracts that were being manufactured both in England and Natal. The normal bark contains about 32 per cent. tannin, whereas the extracts contain from 60 to 65 per cent. tannin. There was a good response to the Institute's action, and both the bark and the extracts found an expanded market. This led to the accumulation of stocks of spent bark, and the Institute initiated experiments on the preparation of pulp for paper making. These experiments have been successful in proving that (1) the dried bark yields 30 per cent. of pulp suitable for manufacture into a very good brown wrapping paper, and that (2) the wood yields pulp which is of a rather poor strength owing to the shortness of the fibre, but when mixed with equal parts of bark pulp makes a satisfactory straw board.

AUSTRALIAN LEATHER AT THE FRONT.

A report upon the quality of Australian leather used in the manufacture of Australian boots supplied to soldiers on active service has been received from the Secretary for Defence. In his report, Mr. Trumble says:—

"Vast quantities of Australian boots, harness, saddlery, and leather equipment were used for military purposes in France, Egypt, and Palestine during the war, and only in respect of two classes of leathers were any complaints received, namely, the bark-tanned sole leather in the Australian boots and the light chrome-tanned leather used in certain parts of the personal equipment of the men. The equipment referred to was only provided in view of the extreme shortage of the correct pattern, and was not intended for use on the fighting front; it was an expedient. No complaints whatever were received regarding the wearing qualities or suitability generally for active service of any of the harness and saddlery forwarded from Australia, and, although numerous complaints were received during the winter months in respect to the Australian boots in wear on the Western front, it was found, after thorough investigation, that such complaints were also made in respect to all patterns of boots in use, and it was eventually recognised that no boot would remain watertight for any length of time under the conditions existing in France and Belgium during the winter. Moreover, there is a considerable weight of evidence that the temporary substitution of Imperial for Australian pattern footwear led to an increase in the number of complaints received. This, however, it is considered, was due to the greater comfort of the Australian boot.

"After numerous tests by practical use in the field and by dissection by experts in London and Australia, it was generally conceded that, whilst the Australian upper leather was equal to the best procurable in England, the sole leather compared unfavorably with that tanned in the United Kingdom. The inferiority of the Australian sole leather was considered to be due to the failure of tanners to allow the hides to remain long enough in the pits."

WATER RESISTANCE OF SOLE LEATHER.

There is a note in the issue of *Science*, of 27th June, by Messrs. H. P. Holman and F. P. Veitch, upon the subject of "Testing materials for increasing the water resistance of sole leather," in which it is stated:—"To determine waterproofing value, several pieces of sole leather, which are always of the same tannage and from the same section of the hide but which differ in texture, are impregnated by immersing in the treating material for ten minutes at 60° C., followed by warming in an oven at 60° for fifteen minutes. Water absorption is determined by soaking in water for twenty-four hours, with periodical flexing, and weighing the wet leather after removing all excess from the surface. The leather is also weighed before treating, after treating, and in the air dry condition after testing. From these weights the quantity of treating material taken up by the leather, the actual water absorption, and the loss in weight on testing, are calculated in percentages. The actual water absorption is calculated on the basis of the final dry weight. All dry weights should be made after exposing

the leather to the same atmospheric humidity. Eighty samples, including practically all the commercial materials used in waterproofing sole leather, were tested by this method. Only twenty were found to waterproof sole leather sufficiently to prevent its absorbing an average of more than 35 per cent. of water under the conditions of the test. This percentage was arbitrarily adopted as a limit for satisfactory materials for increasing the water resistance of sole leathers."

COST OF WORM NODULES.

The losses incurred through the presence of worm nodules in Australian beef is illustrated by the following report by Mr. D. J. Kerr, Chief Veterinary Officer of the Department of Trade and Customs:—

"When it is considered that 14 per cent. has had to be removed from each carcass of beef exported from Australia during the past ten years, and assuming the approximate annual average of cattle available for export from Australia as being 500,000 carcasses, that is of 5,000,000 carcasses for the ten years of, say, an average weight of 650 lbs. each (total 3,250,000,000 lbs.), the amount of 455,000,000 lbs. (14 per cent.) has been excluded. Taking the average value of brisket meat during the past ten years at 2d. per lb. in Australia, and the exportable f.o.b. value as 4d. per lb., it will be seen that the loss to the industry has been enormous, *i.e.*, £3,800,000 (approximately), or £380,000 per annum."

THE MANUFACTURE OF EPSOM SALTS IN AUSTRALIA.

Until a few years ago, most of the Epsom salts used in Australia came originally from Germany. They occurred there as the compound kieserite, an important part of the great Stassfurt deposits of Germany, which was the source of supply also for the world's potash. Germany, however, did not possess a monopoly of kieserite, and the salts were manufactured in America, India, Greece, and Italy. Now Australia is added to the list, and we have "Made in Australia" Epsom salts instead of the "Made in Germany." Epsom salts is largely used as medicine, and may be regarded as a typical saline purgative. Its action is dependent upon the minimum of irritation of the bowel, and is exercised by the abstraction from the blood of water, which passes into the bowel, to act as a diluent of the salt. The stronger the solution administered the greater is the quantity of water that passes into the bowel—a fact to be borne in mind when the salt is administered for the purpose of draining superfluous fluid from the system, as in dropsy. It also has a stimulating action on the glands. In Australia, magnesite is used as the source of supply. It is a fine-grained, compact mass, white to yellow, according to purity, hard and brittle, and is a carbonate of magnesia ($Mg.CO_3$) This occurs in three different types of deposit:—

(1) In irregular veins in magnesian igneous rocks. It is a decomposition product from the decay of the rock material.

(2) In beds associated with deposits of rocksalt, gypsum, &c. Here it is a direct deposit from concentrated saline waters.

(3) In beds interstratified with slate, shales, limestones, &c. Here it is due to replacement of lime by magnesia.

In most of the workable deposits, it is from the first type that the material is obtained in Australia.

The process of manufacture covers such operations as the following:—Calcination, reduction, crutching, filtering through press, crystallization, and drying. The rock is placed in a kiln on a bed of coke resting on wood, and packed up with alternating layers of coke. Water is first driven off, and at 400° C. the carbonate breaks up. If lime is present, it may delay the breaking up, and require a higher temperature. At 800° C., however, the reaction is complete. The best type of kiln is known as the mixed feed kiln, which is cheaper, both in first cost, and in operation expenses. The burnt magnesite—now magnesia Mg.O., is drawn from the kilns and passed into a pulverizer. Next follows the crutching process. This is carried out in lead-lined vats, into which the magnesium sulphate brine from previous lots, and a definite charge of H_2SO_4 is gradually run in, and the powdered magnesia added gradually with continuous agitation. The specific gravity of the charge is kept as near possible to 1.4. This is important, as it determines the nature of the salt crystals that form. The temperature is kept about 65° C. The charge is next pumped through a filter press. This removes all insoluble matter, *e.g.*, sand and calcium sulphate, &c. The clear solution is placed in shallow galvanized-iron trays for crystallization. In about twelve hours, good crops of crystals are formed, and the supernatant liquor is siphoned back to the brine vat. The crystals are well drained and dried by a centrifugal drier. This revolves at 1,000 to 2,000 revolutions per minute for twenty minutes for a charge of 2 cwt. The crystals are then shovelled on to large drying tables, and a further 1 per cent. of moisture is lost. The salt is then ready for marketing—if it conforms to the following tests:—

> No impurities of zinc should be present, and no trace of chlorides. The salt should be a pure sulphate of magnesium, with very little trace of iron compounds.
>
> The limit for lead and arsenic is 5 parts per 1,000,000 for each.

Such is a bare outline of the process, but by the use of up-to-date methods of manufacturing, with good labour conditions, and the production of an article that conforms to the high standard of purity of the British Pharmacopœia, the locally made salts deserve every success.

ENGLISH CRITICISM OF AUSTRALIAN LEATHER.

The following criticism of our leather has been received from the Imperial Institute:—

"Australian leather is regarded as suitable for certain purposes, *e.g.*, for the upper leather of boots or for the manufacture of harness, saddlery, &c., but it is generally held that it is not, as a rule, sufficiently water-resisting to be suitable for general use for soles in wet climates. The leather is often too soft and too lightly tanned. It is suggested that it could be improved by tanning for a longer time in stronger liquors, or by the use of a mixed tannage instead of wattle bark alone. It is understood that certain tanners in Australia are now adopting the latter plan and are using wattle bark mixed with myrobalans, chestnut extract, &c., thereby producing a superior leather, which is satisfactory. If the use of mixed tannages were generally adopted in Australia a considerable improvement in the quality of sole leather would result."

LOCAL PRODUCTION OF POTASH.

As mentioned in the first issue of the *Journal,* the Sulphide Corporation has been investigating the possible sources of potash in *South Australia.* They have produced a few tons, but on account of the low grade of the deposit, transport charges are heavy, and the prospects of producing potash at a price that will stand competition from the usual sources are not encouraging. From *Tasmania* we have received information that small quantities of potash are being produced at Pelican Island. The kelp, which occurs in extensive beds along the coast near Southport, is collected and crudely burnt, yielding weekly about one ton of potash (28 per cent. pure) from 30 tons of kelp, and valued at £30. With sufficient capital to provide for the installation of plant and machinery for gathering and drying the kelp, and the establishment of better methods of burning and extracting all the by-products from the ash, the local production should be successfully exploited.

Reporting on the Bulladelah deposits in *New South Wales,* Mr. Carne, Government Geologist, states that the possibilities of the deposit could be extended by roasting and grinding the rejected "seconds," and utilizing the product as a fertilizer. The Western Australian Mines Department is having some hundreds of tons of alunite conveyed from Kanowna to Kalgoorlie, where it is roasted, and is to be sold in that state to farmers.

TRAMWAY RAIL CONFERENCE.

Following upon the agreement arrived at for an Australian standard specification for railway rails and fish-plates, the Institute of Science and Industry convened a conference for the purpose of fixing an Australian standard specification for tramway rails and fish-plates. The conference commenced on Monday, 4th August, and terminated on 7th August, having arrived at mutually satisfactory conclusions. The profile of the rail, as was anticipated, occasioned long discussion, but a compromise was eventually effected. Professor Lyle again acted as chairman; others who were present being Messrs. Alex. Cameron (Chairman of the newly-formed Melbourne and Metropolitan Tramways Trust), G. R. Cowdery (Chief Engineer, New South Wales Government Tramways), W. G. T. Goodman (Chief Engineer, Municipal Tramway Trust, Adelaide), P. J. Pringle (Chief Engineer, Ballarat and Bendigo Tramways), M. E. Kernot and E. Adderley (Victorian Railways), H. J. Dix (Prahran and Malvern Tramway Trust), A. D. Murdoch (North Melbourne Electric Tramways), Struan Robertson (Hawthorn Tramways Trust), S. S. Jobbins (Geelong Tramways), and M. R. Westcott (Coburg Tramways). Representatives of Western Australia and Tasmania were unable to attend owing either to influenza or to the dislocation of steamer service. Mr. R. H. Rowe and Mr. Ballard represented the Broken Hill Proprietary Limited, and Mr. C. Hoskins represented G. & C. Hoskins Proprietary Limited. The work of these two conferences represents only a small portion of a large scheme of standardization which the Institute will undertake, and which, when completed, will enable Australia to maintain and develop her engineering and subsidiary industries.

CULTIVATION OF GUAYULE RUBBER.

A proposal has been brought before the Institute by Mr. W. Ham, of Adelaide, to introduce into Australia the Mexican plant—*Parthenium argentatum* (A. Gray)—known as the source of Guayule rubber. The chief characteristics that recommend its introduction are:—

The plant lives in very dry soil, with a rainfall less than 10 inches a year, and often in rocky ground containing a large percentage of lime.

Many experiments are being made with it in California and Arizona, and experimental manufacturing plants capable of producing annually 400 tons of purified rubber are in use.

The plant is of slow growth, but cultivation and hybridization seem likely to yield improved strains. Machinery for planting out seedlings, cultivating, and harvesting have been devised to reduce the cost of manual labour to a minimum. As the whole plant is cut down and ground up to obtain the rubber, all the operations can be performed mechanically. The amount of dry rubber yielded varies from 7 to 10 per cent. of the plant weight, and is chiefly contained in the bark.

It was decided to write to the Department of Agriculture at Washington for full information on the matter, and for a supply of seeds for introduction here.

SUN-POWER APPARATUS.

That evergreen subject, "How to convert the sun's energy into mechanical energy," has again been brought before the Council of the Institute of Science and Industry by Mr. F. W. Hiscock, of South Australia. He claims to have invented a sun-power apparatus which will focus the heat of the sun on galvanized iron piping containing impure water, from which steam of considerable pressure can be obtained, which can be either condensed to supply pure water at a total cost of 2½d. per 1,000 gallons, or be converted into power. The Council could not support the proposal in its present form, and costs of an apparatus in use in Egypt were supplied by Mr. Leighton, of the Commonwealth Arsenal, as 3s. 7½d. per 1,000 gallons. It was decided to write to the Egyptian Government for full information on their plant and specially designed low pressure engine.

DESTRUCTION OF RABBITS BY DISEASE.

Another subject that is the cause of much controversy, and also of much opposition, is that of controlling the rabbit by the introduction of some specific disease. Nothing of a practical nature in this direction has been attempted since the investigations of Dr. Danyz on an island off the New South Wales coast many years ago. Information has been received from Dr. Aragao, of Rio Janeiro (*per* Dr. Breinl, of Townsville), about a disease of a very deadly nature that attacks only rabbits and hares. All the domestic animals (pig not mentioned), horse, cow, sheep, dog, cat, fowl, and pigeon are immune. Dr. Breinl has offered to carry out any preliminary tests on caged rabbits. The matter has been submitted to Sir Harry Allen, Pathologist, Melbourne University, for a report.

GETTING RID OF SPECKS.

As is often the case when new processes or materials are tried out on a manufacturing scale, a new difficulty arose. Paper makers complained that the paper produced from the wattle pulp contained objectionable small black specks, which were believed to be derived from the corky layer of the bark. The Imperial Institute again conducted experiments, and two methods of avoiding the difficulty were tried, and one of them carried to a successful conclusion. This latter consisted of sifting the ground spent bark to remove the corky tissue. The bark was partly air-dried from normal, 71 per cent. to 45 per cent. moisture, and sifted through a sieve with eight meshes to the inch. About 62 per cent was left on the sieve, and when this was converted to pulp by the soda process, yielded about 10 per cent of the original weight of bark as dry pulp. This produced a paper with comparatively few specks. The sifted bark required less caustic soda to convert it to pulp, and the paper was superior in quality to that made from unsifted bark. The results of the process on a large scale would appear to be:—

(1) A loss of crude material due to sifting, and varying from 30 to 40 per cent., according to the moisture of the sifted material.

(2) A gain of 2 per cent. more pulp than from the crude unsifted bark, thus requiring 3 per cent. less caustic for its conversion.

(3) An improved quality of paper.

In the second method tried, the bark was beaten up and the corky material was found to be heavier, and could be separated by suitable appliances, or washing over sieves. The process requires trials on a larger scale. It is thus possible to convert spent wattle bark or wood into pulp and manufacture this pulp into satisfactory paper or straw board. Further investigation, however, is still needed, as the cost of transport of the spent bark from the tan yard to the paper mill is a heavy handicap. Typical samples of bark contained 71 per cent. of water, and yielded only 10 to 12 per cent. of its weight of dry pulp. It is uneconomical to transport any distance material containing such a percentage of water. It is essential to dry the bark as far as possible. This is not readily done by spreading it out and turning it over occasionally. Experiments are being carried out involving the use of some form of waste heat, and also the use of compression. The results will be awaited with interest, as the whole question is of great economic value to Australia.

SCIENTIFIC RESEARCH IN SOUTH AFRICA.

The Research Grant Board, which has been established by the Union Government in South Africa for the encouragement of scientific research, has recently announced its scheme for awarding research scholarships and making grants towards the expenses of scientific research. The scholarships will vary in value from £80 to £250 per annum for one or two years, and may be awarded for a further period. Applications must be made through, and with the approval of, one of the governing bodies of the higher educational institutions of the Union or of a museum or research institute.

EDITORIAL.

PROPOSED IMPERIAL CONFERENCE OF ENTOMOLOGISTS.

It has been suggested by the Imperial Bureau of Entomology that a conference of entomologists of the Empire, which was deferred during the war, should be held in London at an early date. The objects of the gathering are to discuss problems of Imperial importance in the prevention of the spread of insect-borne diseases, and to afford an opportunity of placing the entomologists in closer touch with the Bureau of Entomology and of settling lines on which the Bureau may render further assistance to the different parts of the Empire. An invitation to the Commonwealth Government to participate in the scheme was recently sent by Lord Milner, Secretary for External Affairs, and the matter has been referred to the Institute of Science and Industry for consideration. The Director, Professor Watt, Mr. G. Valder, Dr. S. S. Cameron, and Mr. A. E. V. Richardson have been appointed a special committee to inquire into the proposal and to prepare a recommendation for submission to the Government.

Manufacturers and primary producers are invited to state their difficulties to the Institute's Bureau of Information, which will assist them where possible.

Two more Bulletins, one on Cattle Tick and another on Posidonia Fibre, together with a pamphlet on Engineering Standardization, have been issued during the month from the publishing department of the Institute.

It has been decided that a nominal charge of 6d. for each Bulletin and Pamphlet issued by the Institute, and 3d. for each circular shall in future be charged, so as to restrict the demand to those genuinely interested.

The Department of Scientific and Industrial Research has forwarded to the Institute a number of copies of *A Study on the Performance of Night Glasses*, by L. C. Martin, D.I.C. These can be obtained on application to the Secretary.

An informative pamphlet, by Gerald Lightfoot, M.A., on "Engineering Standardisation," has been published by the Institute.

The technical and scientific library of the Institute is each day being made more complete, and is available for the inquiring public.

The Making and Improvement of Wheats.

By HUGH PYE.*

(I.)

MY mission is to stimulate the imagination of the wheat-grower in respect to the practical bearing of plant-breeding and selection on the progress of his life-work. To impress him with the marvellous strides made, during less than a century, in plant development, and the need for still greater progress. To impress him, too, that he has his part to act, side by side with the plant-breeder, in enriching the store of human knowledge, by bringing to bear keen observation and intelligence, acquired by being in an environment where he can note every phase of the life of the plants he grows. A farmer has only to begin the work in earnest and the results obtained will convince him that his few stud plots are an inspiration to real and lasting success, and that their establishment is an almost essential part of his farm practice, and will prove a profitable investment. His intelligent son, or daughter, with a little encouragement, would become so absorbed in the work, that on the farm would be the only place worth living. The city would have fewer attractions.

Why different Varieties may be Grown in Adjacent Rows.

Wheat is a self-fertilizing plant under normal conditions, hence several varieties may be grown in adjacent rows without there being any cross-fertilization, though on a few rare occasions this happens, as when thrips have eaten the pollen cases, or they are sterile in pollen. Then the floret opens, and the stigma may catch any wind-blown pollen.

The Farmer doing his Part.

If we could discern more closely, it would be noticed that in what is practically a pure crop, individual differences would be observed among the plants of the crop, and in some instances marked differences will be noted. It is with these plants the farmer may do good work in establishing new strains. Many farmers have done so in the past; more should do it in the future.

The great advantage a farmer has in improving a variety that has been proved to be suitable to his soil and climate, is the fact that there is less loss of vitality in the variety by continuously growing it, where proper rotations and cultivation are adopted, and the strain is improved by continuous selection. Thus, at the College, there are grown under these conditions varieties that have not been changed, except by selection within the varieties, for the last 25 years; and when tested against introduced seed of similar ones, give much better yields. This is due to the fact that the northern areas are particularly suitable to the production of the best wheat. If, on the other hand, the climate and soil were not suitable, a change of seed is an advantage.

*Principal of the Dookie Agricultural College, and a noted cerealist.

In the present state of the business side of wheat-growing, farmers have no encouragement to grow the highest class of wheat, hence he grows varieties which give him the greatest number of bushels per acre, irrespective of quality. When wheat is bought according to its strength and proteid quality and percentage, keener interest will be taken in the higher-class varieties. I believe the Department of Agriculture would encourage farmers who take a real interest in establishing prolific strains of high and gluten-content strong wheats, by milling them in the test mill, and report on their quality.

Change of Seed.

The idea that a change of seed is necessary is probably due to the fact that vegetables, and other plants pollinated by the wind or insect borne pollen, in course of time deteriorate by continuous cross-fertilization within the variety, or by being cross-fertilized by pollen of other varieties, or by varieties of another species of the same genera.

In the two latter instances, the variation in the progeny will be noticeable, and the work of fixation must be carried out to establish the new types formed. In the first instance, the continuous inbreeding within the variety seems to devitalize the stamina, just as unregulated incestuous breeding among animals does; still, when this incestuous breeding is carried out by a master mind on definite and systematic lines, good results are obtained; but they are artificial and need an artificial management, or retrograde results will soon be in evidence. Even when incestuous breeding is carried out for a lengthened period, sterility ultimately results, or the stamina is impaired to such an extent that the results amount to the same thing. To some extent, this occurs among self-fertilized plants. The pollen becomes deficient in quantity and vitality, and florets open to seek for wind-borne pollen, and if not fertilized by it, die out.

En passant. I may mention, as a matter of interest, that, on a few rare occasions, I have found what may be termed violent crosses so deficient in pollen that the variety has died out. This, of course, is quite a distinct phase of the subject under notice.

Returning to the effect of a change of seed in regard to wheat, it will be apparent that, as self-fertilization takes place wherever the plant may be grown, and that merely changing the environment does not alter the natural procreation of the variety, it follows that no object is gained by a change of seed in respect to this inherent quality. Any improvement, then, that may occur is likely due to better food supplies to the plant, greater care taken to keep the seed selected and graded, or better climatic conditions to suit the variety.

Modern Varieties are Artificial Productions.

Another view of looking at the subject is that the modern wheats are man-made productions, just as the modern breeds of sheep are. They are artificial creations made for specific purposes, and can only be kept true to the type decided on by selection, suitable food, and living in an environment conducive to it. We know that if a flock of perfectly woolled sheep is taken from one climate to another quite distinct, the nature of the wool changes. It may become more like hair in spite of

care in selection, but because the wool of the original flock is in demand, it is necessary to keep as nearly similar to it as possible; but as this is fighting against nature, it is more costly to produce on equal land values, and then it is only a relatively good or bad substitute. This applies possibly to animals and plants alike. It is nature warring against man all the time, and it leads one to think it is better to perfect the strain of plant or animal that the environment lends itself to.

Perfect the Strain Suitable to the Environment.

Is this not a sufficient reason for wheat-growers to carry out seed selection on their own farms, and establish varieties best suited to their environment?

When wheat-buying is placed on a proper systematic basis, the miller can so blend the wheat that the flour may suit every trade, whether it be the baker, the pastrycook, biscuit manufacturer, or the patent-food maker.

There is a market for all, and although one class of grain may bring the highest price, if grown in the wrong environment it is likely to be of poorer milling quality, or less prolific.

By experiment and selection, a farmer may produce a variety equally as valuable as the other, especially if he works in unison with the wheat-breeder, who evolves thousands of different seedlings, in order that among the many a few new types may be formed of greater merit than existing ones. A great advance in this respect has been made during the last decade, by the farmers of the Commonwealth, than during the previous one.

(*To be continued.*)

The man of science has learned to believe in justification, not by faith, but by verification.

HUXLEY.

Prickly Pear Eradication.

Institute's Scheme Approved.

QUEENSLAND AND NEW SOUTH WALES CO-OPERATE.

At the end of 1916 the Executive Committee of the Advisory Council of Science and Industry recommended a scheme for attacking the prickly pear problem by the Institute working in co-operation with the Queensland and New South Wales Governments. The cost estimated at £8,000 a year for five years was to be jointly borne, the Commonwealth finding half, and each of the States one-fourth. The Queensland Government immediately agreed to the scheme, but the New South Wales Government did not immediately approve. Its acceptance, however, has at length been accorded, and no doubt immediate steps will now be taken to put it into operation. The actual scheme is as follows:—

(*a*) That investigations should be carried out as to the suitability of insects and fungi known to be inimical to prickly pear for acclimatization in Australia, as to the method of action of such insects or fungi on the pear, and as to such other matters as may arise in connexion with any biological or chemical researches found necessary.

(*b*) That the work should be placed under the authority of a biological expert who shall be responsible to the Executive Committee of the Advisory Council of Science and Industry, and who should receive a salary of £1,000 per annum.

(*c*) That three laboratories, comprising one central laboratory and two subsidiary laboratories, should be established and maintained in Queensland and New South Wales.

(*d*) That the central laboratory should be established at Brisbane, where the insects would be received immediately they reached Australia, and where the staff would have access to literature and facilities for the use for special investigation of University and Government laboratories.

(*e*) That the two subsidiary laboratories should be established in country infested with prickly pear. One of these should be in New South Wales, whilst for the other the Queensland Government's offer of the Dulacca Experiment Station should be accepted. These stations would carry out the work of breeding and testing the introduced insects, and should be in charge of thoroughly qualified entomologists, at salaries of £650 per annum.

(*f*) That field laboratories should be established at such places and at such times as may be deemed necessary by the biologist in charge for the purpose of introducing such insects as are found suitable into particular areas, or for other special purposes.

(*g*) That the sum of £8,000 per annum for a period of five years should be made available for this work, of which sum £4,000 should be contributed by the Commonwealth Government, and £2,000 each by the Governments of New South Wales and Queensland.

In making these recommendations the Executive Committee had in mind the fact that from the point of view of Australia as a whole the most important object to strive for is to prevent the spread of the pear on waste lands from which good lands are constantly threatened. This can only be done by employing natural enemies, since mechanical or chemical methods are too expensive on waste lands. The experiments carried out in the past have had as a primary object the discovery of means whereby the landowner might clear more or less valuable land. Though of great importance to persons in the pear-infested localities such experiments are in the nature of a search for remedies, whilst from the national point of view what is required is something to hold the pest in check and ultimately destroy it, that is to say a cure.

The Executive Committee considers that the matter is of such importance that the full-time services of several entomologists should be employed in obtaining insects from America and investigating their action on the plant. Though the State Governments have biologists and entomologists in their employment these officers are obviously only able to give a portion of their time to such work.

The Commonwealth, New South Wales, and Queensland Governments have all agreed to the scheme outlined by the Executive Committee. The New South Wales Government has also promised to contribute a sum of £1,000 per annum for a period of five years, on a contributory basis with the Commonwealth and the various States interested, for investigations into the extermination of white ants, cattle ticks and nodules in cattle, and such other pests as may from time to time be considered to be of sufficient importance for joint Federal and State action.

It is proposed that the general superintendence of the prickly-pear investigations, especially in so far as the business side is concerned, should be controlled by a Commonwealth Prickly Pear Board consisting of the Director of the Commonwealth Institute of Science and Industry (chairman), the Under-Secretary of the New South Wales Department of Agriculture and the Under-Secretary of the Queensland Department of Lands.

The farmer of to-day is an infinitely more practical man than the farmer of 25 years ago, who sowed and reaped in uncritical imitation of his father, and who gave the old cow her free choice of what food she considered most suitable for herself.

—F. B. GUTHRIE.

Huge Avoidable Losses.

Observations on the Introduction and Spread of Stock Diseases and other "Pests" with Special Reference to "Cattle Tick" and "Worm Nodules" and the Loss Sustained through the Absence of Early Scientific Control.

By Dr. J. A. GILRUTH.*

THE necessity for the application of science in the conduct of industry has been emphasized during the progress of the war. It has become manifest to every one, especially in the manufacture of means of offence and of defence. Inferentially, the loss from its absence in the past is becoming realized, but hardly yet in every-day affairs, and it is now generally accepted the Germans have suffered less in this respect than any other community.

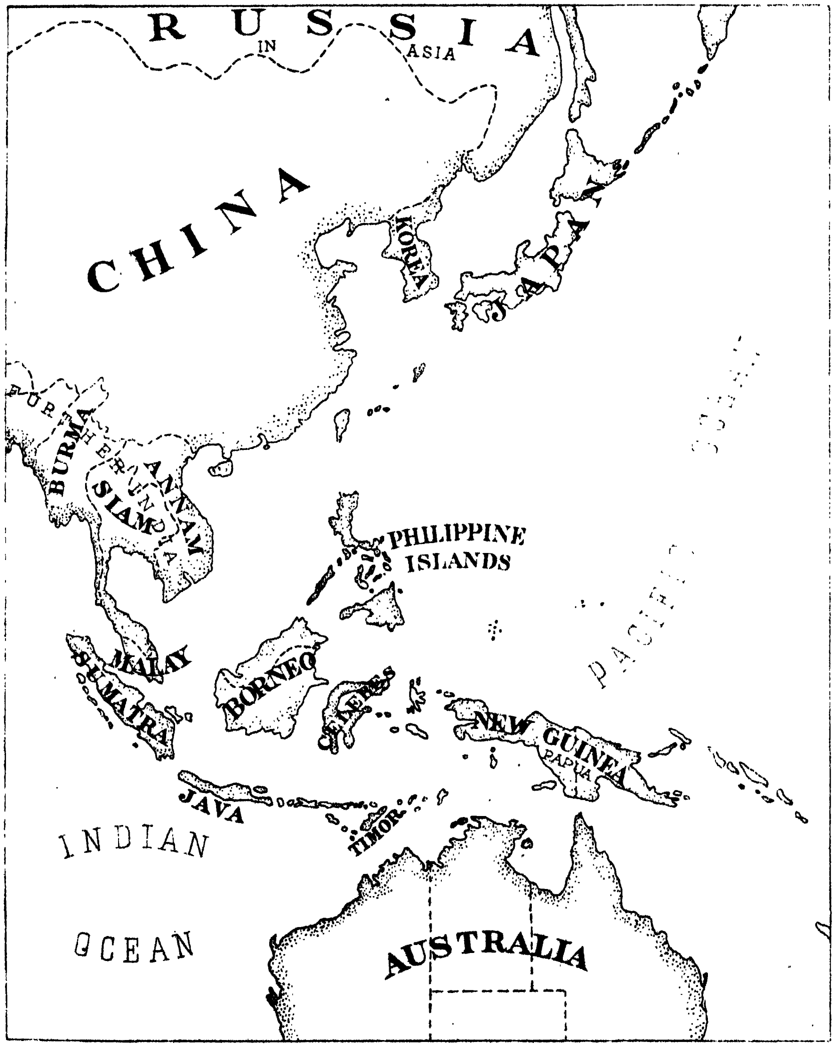
As cattle, sheep, and horses were not indigenous to Australia, it might have been possible to prevent the introduction of any contagious animal diseases when the foundation of our herds and flocks was laid. It is true many complaints common elsewhere were not introduced, but before an effective system of inspection and quarantine was established serious diseases gained entrance, and still cause annual losses. Some of them, such as tuberculosis and pleuro-pneumonia of cattle, because of the absence of symptoms in all but the later stages, it would have been difficult to prevent with the knowledge then available. Others could have been prevented had scientific knowledge been applied. Notably this is the case with sheep-scab, which was happily eradicated years ago, but at considerable expense.

Cattle Tick and Redwater.—In August, 1872, an incident occurred at Port Darwin which, though apparently of only local significance, was fraught with disastrous effects to tropical Australia. The population then mostly consisted of a few officials and the officers of the British Australian Cable Company, which had established the first telegraph link between Australia and the rest of the world. The settlement was short of fresh meat. The nearest supplies in Australia were distant a month's journey by sailing vessel. The company's schooner was therefore sent to Java for cattle, and in due course eight cows and four bulls were landed. These were of the Brahma or Zebu variety, characterized by the shoulder-hump. No examination was made for disease, and the presence of external parasites was ignored. That these cattle must have carried ticks is undoubted. All cattle in the East are more or less affected, but, being immune to redwater and carefully tended, the parasite causes little or no harm. Still, it is equally certain that had they been examined by an entomologist or veterinary surgeon, some steps would have been taken to prevent the introduction of such parasites to a new and empty country. Had these cattle all been killed off for meat, nothing serious would have occurred, but several escaped into the bush, and for a number of years were not heard of. Although there is no official record of this importation written at the time, I was able some years ago to secure the facts from several gentlemen who were present during the disembarkation. Prior to that, where and when the tick was imported into Australia was a mystery.

The Queensland records of tick fever showed clearly that it first appeared as a serious complaint in the Gulf district about 1893. In the Territory, the first outbreak which I have been able to trace occurred in 1881 near Glencoe Station, 100 miles from Darwin, in a mob of cattle brought from Queensland by Mr. W. Lawrie. In the previous nine years several mobs of cattle had been overlanded from Queensland to Port Darwin with no appearance of redwater *en route*, or after arrival, while they were being held for slaughter. Yet of

* Administrator of the Northern Territory.

the 1881 mob nearly 50 per cent. died of redwater between Glencoe and Darwin. Subsequent importations from Queensland suffered a similar mortality on reaching that district from the same disease. About 1886, it appeared at the Katherine River in cattle being travelled by Mr. A. Giles from Newcastle Waters



MAP SHOWING AUSTRALIA'S CLOSE CONNEXION WITH THE EAST.

far to the south, and a heavy mortality occurred before Darwin was reached. Previously, redwater had been unknown at the Katherine. From both the gentlemen named I have had the above facts. Redwater became so serious about this period as to be noted in the official reports. In 1887, it had appeared in the vicinity of the Roper River, and it was officially stated to be the *bête noire* of drovers *from Queensland,* clearly indicating the cattle from that Colony were then possessed of no immunity.

It is necessary before proceeding further to connect up the Javan importation with the cattle coming from Queensland, especially the first mob to be affected with redwater at Glencoe.

The Zebu cattle which escaped to the bush would gradually reach the Adelaide Plains, a few miles inland, and in the nine years must have increased considerably. Although in the Indies these cattle, being kept in very small numbers in daily contact with the natives, are extremely docile, when given liberty they become very wild, much more so than English breeds of cattle. Their descendants crossed with British breeds may be found amongst the Adelaide River herds to-day, and they are always characterized by a greater difficulty to drove and manage than the others. Zebus with all the characters of the pure-bred are still occasionally seen. Three years ago, a typical bull broke through the fence at Batchelor Farm, and remained with the herd for some time. Attempts to domesticate him failed, and eventually he went as he came. A settler, Mr. Milton, secured two pure-bred bull calves in the bush, and they, being paddocked, became docile. In the wild state they are not readily seen in the thick bush country, and it is impossible to say how many still exist. These facts are mentioned to show the Zebus persisted and travelled inland. In the long dry season they would frequent the rich plains, but in the summer the plains become swamps, and the high lands are sought. From the sea inland, the Adelaide River

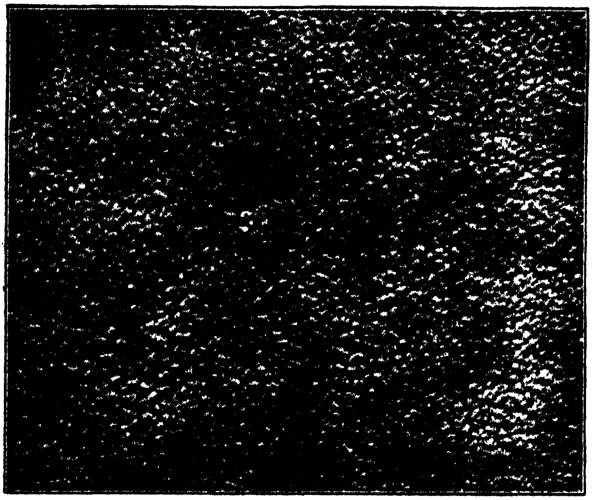
TICK-INFECTED STEER.

This could have been avoided by early scientific inspection of shipment of cattle from the East.

is unfordable until the railway crosses it, and there also was the main road to the interior. Glencoe Station from there is less than 20 miles away. It is certain the wild cattle would pick up with strays from the travelling mobs who would wander back along the track they had come, dropping ticks by the way. From what we know now, a comparatively few female ticks dropped near the waterhole at Glencoe would suffice to infest with redwater a non-immune lot of cattle. Thus the first outbreak is accounted for. All the facts fit in and form a complete story.

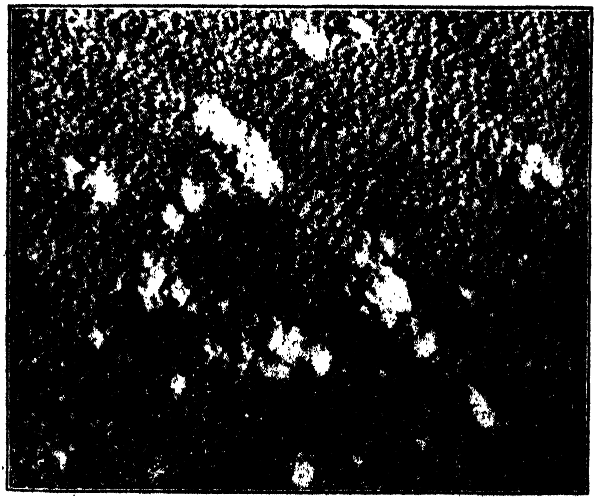
The spread inward to the Katherine, the Roper, and McArthur rivers is easily explained. Cattle suffering from disease drop out of a mob, and are left to die or recover. Those which recovered from a slight attack would naturally wander backward along their route dropping infected ticks. By 1890, it was observed that "Redwater does not attack acclimatized or Territory-bred cattle," showing that immunity was being acquired. The introduction to Queensland proper was undoubtedly expedited by the establishment of the Burketown

Boiling-down Works on the Gulf. A market was opened for cattle, and a number of mobs were taken there from the Territory, particularly from the McArthur River.



A PERFECT HIDE.

By 1894, the position was so serious in the Gulf that Mr. Pound, Government Bacteriologist of Queensland, was commissioned to visit the district and report. As a result of the exhaustive experiments carried out on Texas fever



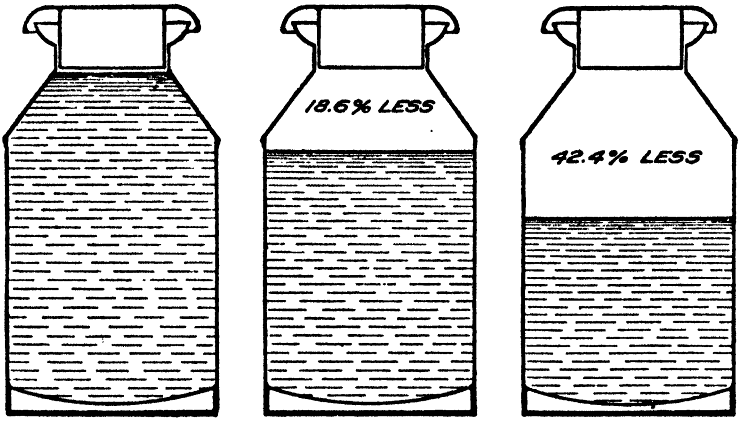
TICK-DAMAGED HIDE. A SAMPLE OF AVOIDABLE LOSS.

(redwater) in America by Smith and Kilbourne, who first proved the connexion with ticks, Mr. Pound was able to demonstrate the similarity, if not the identity, of the two diseases.

Meanwhile, owing to the opening of meat works at Townsville, cattle were being driven from the Gulf to the East Coast, and the community, not being yet convinced of the real seriousness of the tick, the contention being hotly

contested by most cattle men, the parasite was rapidly conveyed to the centre of the cattle areas of the north. Its subsequent spread over the whole of what may be termed the "tickable" area of Queensland I need not dwell upon. The point to emphasize is that had more foresight been exercised, or had that apparently innocuous entry of Indian cattle to Darwin in 1872 been prohibited, the saving to Australia would have been incalculable. The loss from ticks and tick fever probably represents a much larger sum than that due to the late war, and prevented the development of the tropics.

Worm Nodules.—Not only did these Javan cattle introduce the cattle tick, but they probably introduced the worm nodule, whose presence in the briskets of the majority of cattle bred in Queensland and the North has resulted in the prohibition of beef briskets by the British authorities. Although the parasite causing these nodules is in no way dangerous to human beings, the monetary loss occasioned to the cattle-owner amounts to an enormous sum annually. The parasite is confined to cattle. It is not present in European cattle elsewhere, save in the few found in the Dutch Indies, the ancestors of which were imported from Australia. The only part of the world where the same parasite affects native cattle is the Dutch Indies, where the inquiries of Dr. Georgina Sweet showed it to be very prevalent. The distribution of the parasite in Australia



Milk from Tick-Free Cows. From Cows with Few Ticks. From Cows with Many Ticks.

DIAGRAM SHOWING DIMINUTION OF MILK YIELD DUE TO TICK-INFESTATION.

Another example of avoidable loss.

indicates it came from the North. It is unknown amongst Victorian-bred cattle, though frequently found in Queensland cattle fattened in Victoria and killed at the Melbourne Abattoirs. Near Sydney it is occasionally seen in locally-bred cattle, and the further north the more commonly is it found, till in the Territory the cattle are almost all affected. It is therefore certain the source of Australian infection was the Javan Archipelago—the original home of the parasite.

In the absence of any exact knowledge as to the means whereby the parasite is spread from one cattle beast to another, it is impossible to state definitely that the Javan importation of Zebu cattle in 1892 was the only means of introduction to Australia. Early in the century—1826-1828—the military settlements at Melville Island and Port Essington introduced some cattle from Timor and Sourabaya. There is now no trace of cattle on Melville though buffaloes introduced at the same time are numerous. On the Coburg Peninsula I am informed a few are yet to be found, descendants of the original cattle, but none have ever wandered south and mingled with station herds, and no European cattle have ever been seen nearly so far north.

In the absence of a knowledge of the intermediary host, which we know is necessary for the development of the parasite, one cannot hold the military importations guiltless, especially in the absence of any scientific examination

of the descendants of these cattle. Neither can we say definitely that the parasites were not originally introduced from Java by other means. The fact that in Darwin imported Victorian cattle have remained free from the worm nodule when kept in close proximity but not in actual contact with infected local cattle, while other Victorian cattle in actual contact invariably become infested, indicates that the intermediary host does not travel far. Yet, again, if this is so, it is difficult to account for the rapid spread of worm nodules to Queensland, and even to New South Wales, in comparison with the relatively slow spread of ticks. We know that in the early nineties worm nodules were common in cattle slaughtered at Brisbane, whereas ticks were not seen until very much later.

Another pest that could have been kept out of Australia had proper precautions been taken in early days.

Speculation is not proof, but, although the actual importation of live Javan cattle cannot be accused with certainty of being the only means of introducing the parasite which is so costly to the cattle industry to-day, we can safely assert that prohibition by the authorities of any such importation from the East would have been extremely wise. We are fortunate that few importations were made. But for the absence of regular communication there would have been more, especially had the early military and convict settlements proved successful. Then we might have had amongst our stock much more serious epidemics, such as rinderpest, surra, glanders, &c. The discomforts of the northern climate and the comparative infertility of the soil may have been of more indirect value to Australia than we would like to acknowledge.

HUGE AVOIDABLE LOSSES.

"Surra"—an Indian Disease of Horses, Cattle, and Camels.—For many years the only importations from Asiatic countries have been camels. These beasts of burden have proved invaluable for transport in our waterless interior. They have introduced a form of skin disease due to a parasite which is very troublesome, and might have been prevented from gaining entrance had proper examination and control been exercised. Again, the application of science was neglected. Fortunately, science was successfully applied about ten years ago, when Dr. J. B. Cleland discovered the blood parasite called trypanosome in camels which had been imported to Western Australia. He was able to demonstrate that these blood parasites were of the same nature as those causing the disease surra amongst stock in India, and the camels were destroyed by order of the Government.

"Citrus Canker"—Lemon and Orange Trees.—Like animal diseases, plant diseases have been introduced through the absence of scientific precautions. An example is "citrus canker," a disease affecting citrus plants of all varieties. Many years ago, this was introduced to Darwin by plants from China, and was even propagated in the Government gardens. The small orchards of various settlers became contaminated by plants from these gardens. Fortunately, before it extended to other parts of Australia, its presence was detected by Mr. F. G. Hill, the Government Entomologist. His conclusions were confirmed by other experts, and last year the disease was thoroughly dealt with by the destruction of all citrus plants in infected orchards. Science was in this case applied before any extensive damage was done to the fruit industry of Australia, although the loss to some of the local settlers, despite the compensation awarded, was considerable.

Weeds—Prickly Pear, &c.—In the past, all new countries have suffered through the importation of weeds, some considered unimportant in the land of origin, others recognised to be severe handicaps. Proper scientific control would have prevented the introduction of such troubles to the agriculturist. One need only mention the prickly pear, which, covering already millions of acres in Queensland, is spreading at an alarming rate.

Many weeds have been introduced to Australia, as to other new countries, by ballast brought in sailing ships and dumped anywhere. In Nova Scotia, ragwort was so introduced. It rapidly spread, and soon covered large areas of country. It is responsible for the so-called Pictou cattle disease, a chronic affection of the liver, almost invariably fatal. It was not until the same disease was thoroughly investigated by me in New Zealand that the connexion with ragwort was established. In Southland and in Auckland provinces it was the cause of serious losses in both horses and cattle, and although sheep could apparently eat the plant with impunity, and were useful in its eradication, an almost exclusive diet of it is attended ultimately with fatal results. It is most probable in New Zealand the plant was also introduced by ballast. Scientific control, had it been applied to such cargoes, should have prevented the introduction of that and similar pests. The plant is known in certain parts of Australia, but, so far, no cases of losses in horses and cattle have been recorded.

Conclusion.—It is not to be assumed that the lessons were not heeded. Quarantine laws in relation to stock and plants have been in force for many years, and the expert staffs of all Departments, particularly those of agriculture, in Australasia have been, and are being, continuously increased, although 25 years ago they were practically non-existent. It is well to remind ourselves, however, when calculating how much science may help us in the future, that carelessness in regard to its potentialities in the past has cast on the community serious burdens, the annual losses from which are enormous.

Australia Self-Contained.

NEW INDUSTRIES. WAR LESSONS.

By H. W. GEPP.*

(II.)

In the previous article I grouped the factors which must operate towards the successful development in young countries of new industries under eleven headings—

(1) Natural resources.
(2) Politics.
(3) Finance.
(4) Education.
(5) Organization.
(6) Relations between labour, management, and capital.
(7) Relations between different operation companies.
(8) National efficiency, in its broadest sense, for the attainment of which health and contentment are essential.
(9) Maintenance of the ethical as opposed to the materialistic attitude of mind.
(10) Development of the spirit of industrial citizenship.
(11) Recognition by the country of the value of big companies or corporations when properly controlled.

Having endeavoured to illustrate the relation of the first four of these principles to the main subject, I was proceeding to outline a basis of organization which should be adopted in inaugurating a new industry. I pointed out that a feature of the scheme of organization must be special attention to research work, and that part of the equipment must be a special department which should conduct investigations in consultation with the chief operating men, in so far as the research is related to the operating.

Another link in the chain of organization must be the adoption of means to indicate the relation of the various members of the staff to one another. A good idea is to set this out in the form of a kind of genealogical tree on a large-scale blue print, so that all members know to whom they are responsible and to whom to report. So as to avoid too much "red tape," which a rigid organization sometimes produces, it is advisable to form what is known as a "general staff," to which various members of the regular staff, in view of their special knowledge, are appointed. At general staff meetings, which should be held about once

* General Manager of the Electrolytic Zinc Company of Australasia Proprietary Limited, and a member of the Executive Committee of the Advisory Council of Science and Industry.

a month if possible, and at which the head official present presides, all members are equal, and every matter is subject to free discussion. This scheme affords the head officials the opportunity of gaining a right appreciation of the whole job in such a way as to be generally beneficial.

New industries are often entirely dependent for success upon subsidiary industries, and the development of these must proceed steadily. Each subsidiary industry should be placed in charge of a man specially selected for that work, and whose baby it is. Naturally, he will be generally supervised by the management, and will consult with the head officials. He will be assisted by the chief engineer, chief accountant, and chief chemist or metallurgist; but it must be clearly understood that it is his special job, and he must fight for all necessary attention, as well as assistance.

New industries frequently pass through periods of doubt and depression, calling for considerable courage and nerve on the part of the chief officials. Personality of a high order is called forth in meeting such conditions, since experience can only be indirect when new industries are under development. One of the most interesting essentials of this kind of work is the development by the chief officials of the right spirit in the staff and men. Every effort should be made to develop initiative in all those engaged in the job, from the office boy upwards; and, further, to make every one intelligently understand, firstly, the purpose and intention of his work, and, secondly, how that work is done. If a man is attending a machine, time should be taken to teach him in the simplest way possible how that machine works, and get him interested in it; or, if a man is attending a set of sulphuric acid chambers or electrolytic cells, devote time to teaching in as plain language as possible, and explain by simple examples, what is happening inside. The more a man knows of the details of his job, the better his work will be, and the more interesting we make the work to the men, the more will be removed that deadly monotony which is soul-destroying and so bad in its effects upon efficiency. Special talks by the chief officials to staff and foremen on all connected subjects are greatly needed.

Relations between Labour, Management, and Capital.—Why is the present position so extremely deplorable? It seems to be because the employer is totally ignorant of the attitude of mind of the employee, and the employee equally ignorant of the true standard of the employer. Further, they have no common ideas or ideals, and no common meeting ground.

And who is, say, in the case of a big company, the employer? The employee regards the employer as a big fat man who doesn't care *how* he gets more as long as he gets it. What is the actual case in a public company, where the shares are well distributed? The employer in these concerns consists of a large number of people, many of whom have only a small individual interest, whilst few are amongst the rich class.

The representatives of all these interests—the directors—are regarded by the average employee as the sole owners of the concern, and it is generally considered that they are getting all the benefits. Of course, this is not the case.

But, how does the employer regard his employee? In some instances, as a man who is trying to do as little work as possible for as much as he can get. Doubtless this is sometimes true, but is not the go-slow policy more often an unreasoning protest against conditions which the worker does not appreciate?

In neither case were these the attitudes of mind of the community when war broke out, and all joined hands, prepared for any sacrifice for the good of the country and Empire. It is this attitude of mind which is wanted again.

Admittedly, there are ignorance and faults on both sides, and, being pretty close in touch with both, it is difficult to say on which side the faults are greater. What is required at the present crisis is not criticism so much as constructive suggestion, and, to my mind, one main idea is basic. We need to abandon the theory that a minimum wage is essential, and adopt, instead, the conviction that there should be, and must be, a minimum amount of happiness right throughout the community, with as much over and above, and to the good, as the united brains of the community can, by proper co-operation, evolve and develop.

It is no use our taking steps to inaugurate any number of new industries in this country unless we face and settle satisfactorily this great problem we are now considering.

If we—the whole population of the Commonwealth—do not admit, and are not prepared to make the necessary immediate sacrifices, and will not devote ourselves towards realizing the present serious and regrettable state of affairs, and will not face the fact that contentment, and contentment only, is the basis of true efficiency, of all good work, and all reasonably satisfactory results, then the only alternative is to muddle along in the present haphazard, unsatisfactory way, and await the inevitable. Surely we possess enough constructive ability and ideas to be up and doing—to say to our fellow-citizens, "Let us adopt certain basic facts, and talk matters over dispassionately, realizing that our mental attitude towards life is changing, nay, has already changed, and that all desire to reach a better understanding, and co-operate for the good of our country and for the benefit of our dependants."

Somehow or other there must come into every man's heart pride in his job, so that he shall truly say he is proud to be engaged on a certain job, and knows and respects his employer, and that his employer respects him, for it is not what a man earns in wages that counts, but what he gets out of life. The solution of the problem seems to be in co-operation—co-operation in interests, co-operation to promote health, co-operation to reduce the cost of living, co-operation to see that every one is properly housed, properly protected from the effects of sickness, and, if a man does the fair thing, he should be further protected by co-operation in all that goes to make life worth living.

It was by such co-operation between officers and men that the Australians saved Amiens and made their famous and successful night attack on Villers-Bretonneaux—co-operation based on a mutual confidence and a mutual respect. All experience teaches us that only

thus are good results achieved. Do not we get better results in dealing with our children by becoming mates with them, co-operating with them, rather than by ruling with a rod of iron? Cannot Australians co-operate as readily at home as in France?

Australia imagines she is ahead in industrial conditions, but this is sadly not so. She leads in industrial legislation, which has tended to rather intensify past bitterness, because legislation has regarded wages as the end, and not the means thereto, just as we and the whole world, too, in the past, have regarded money as the end, not the means.

We stand behind the Mother Country in thought and deed. What are they doing in Great Britain? As a first instalment, they are starting to build 200,000 new houses for workers; they nationalized the milk supply to protect the people's health; and instituted a complete reorganization of the education system. They are devoting some of the best brains of the country towards meeting the conditions of the post-war period.

What does man want? Firstly, health; secondly, security of employment, providing he carries out a decent job to the best of his ability; thirdly, insurance against being dragged down to the depths financially, if, unfortunately, he should be sick and unable to work; fourthly, decent housing conditions; fifthly, a fair margin between the cost of living and his income; sixthly, good education and a chance in life for his children; and, seventhly, reasonable civic and social rights—all of which, summed up, imply a minimum amount of happiness.

How shall we endeavour to attain to this position? The answer is by co-operation in all matters—by employers taking a keen interest in the lives of all their employees—by developing a spirit of civic and industrial citizenship, so that a man will guard his job just as he would a public garden running down the centre of a street; by inaugurating co-operative councils, which, with the assistance of the employers, will reduce cost of living to a minimum, and by means of which education in general economics will gradually percolate through the whole community to its lasting good.

If ignorance on both sides as to the attitude of mind of the other side can be eliminated; if we can get together and thereby eliminate the pitiful feeling of distrust and growing hatred that exists at present, there is some hope; but, without it, none at all.

We shall have to minimize the number of non-producers in the community. We must somehow eliminate the tremendous wastage, both of labour and material, involved in present methods of distribution, thereby materially reducing the cost of living. This must be done by intelligent co-operation, in which all the employees, both mental and manual workers, shall have a large, if not a controlling, interest.

The following are a few examples of what is being done in Great Britain, America, and, to a limited extent, here to solve this problem:—

A separate department of the organization is formed in charge of an industrialist, which is just as distinctive as the accounting or engineering department.

A sickness and benefit fund is inaugurated, to which both the men and the company subscribe regularly, and which is controlled and distributed by the employees' representatives, so that if any man is sick he receives up to £2 per week whilst away from work.

A co-operative council is formed, consisting of 50 per cent. of employees' representatives and 50 per cent. of the company's representatives, and this council is advanced money by the employer to inaugurate and operate reasonable schemes for the general benefit of all the employees. Co-operative stores are run by this council, and supply the main essentials of life, the amount saved being given back in the cheaper price of all the articles, not accumulated for subsequent bonus payments. It also inaugurates and carries out special branches of developmental work, such as the erection of children's playgrounds, all labour being voluntary. One striking example is the recent erection of the 10-acre children's playground at Port Pirie, at which over 2,000 men assisted, many of them giving over 100 hours of voluntary work without any remuneration.

In addition, holiday camps are formed for employees by the council, and the cost of taking a holiday with families is thereby reduced to a minimum; in some cases a bonus of fourteen days on full pay is granted for steady attendance to duty throughout the year. In short, every effort is made to make the job a good one to work in, and every one connected with it proud to be there.

It is essential in some way or other to get every one in this country to realize that the only possible way to successfully meet the future is to insure that the will to do good work spreads throughout the community.

Education on these lines of thought and action is more than necessary for us all. From the highest to the lowest we need to fight our old pre-conceived ideas and train ourselves by constant thought to realize that a complete change in attitude of mind is necessary if reasonable success and happiness are to attend our country in the future.

This, often enough entertained and consistently developed, will lead us to actions of the right kind, and will enable us to act in all positions and under all varying circumstances in complete conformity with the best lines of thought.

In my own small way I have endeavoured to think on the lines set out in this paper, developing from discussions and reading for a number of years past, and I am convinced that one of the most urgent needs (provided that the principles set out herein are sound) is for education throughout the whole community and for the development of thought on these lines.

In this connexion it is more than essential that the leaders of industry, in whatever branch, should not overlook that it is essential to pay very considerable attention to all their staff, to see that they fully appreciate and understand the ideas and intentions and hopes of their directors and leaders, so that the attitude of mind and actions shall be carried on through the various stages of the organizations, and that the whole operations and relations between capital and management and employees shall be conducted with that sympathy and understanding without which any actions and advances are foredoomed to failure.

If we can maintain an ethical, as opposed to a materialistic, attitude of mind; if we can appreciate that this is not something to be sneered at, but to be treasured as an insurance against development of the worst side of our nature, then we shall keep ever fresh before our minds the realization of our duty to our country, and to those who have made or have been prepared to make, the supreme sacrifice for us; thus shall we do all we can to assist in building up the great State wherein there is clear recognition of the right of all citizens to happiness and contentment.

We can only "*acquire merit,*" achieve efficiency, and "*deserve*" *success,* and at the same time avoid that attitude of mind which sank the *Lusitania* and sacked Louvain, by maintaining our ideals. And what better ideal can there be than to at once determine to erect as a living and ever-present memorial to the Australian soldiers—to the 59,000 men who have died for us, and to those 200,000 who have been wounded and gassed, and wounded and gassed again and yet again—to erect, instead of a stone and marble monument, a token of our gratitude and appreciation in the form of an industrial system, based upon and guided by the laws of humanity and mutual esteem and understanding?

If determined and persevering, we can build upon such a safe foundation a creditable and durable superstructure of new industries, properly and logically equipped, so that we can produce efficiently, can secure work for the partly disabled men, and provide for all the conditions required to yield our ideal of a community of happy people, strong in their mutual goodwill and confident in their strength.

There are many reasons why agricultural research should form a prominent feature of the activities of the Commonwealth of Australia. Its ultimate aim is to increase the productivity of the country, and it would be impossible to exaggerate the importance of that at the present juncture; for, when the war clouds have passed away, when men have beaten their tanks into tractors and their bayonets into binder-blades (to modernize a scriptural quotation), and peace once more comes to this troubled world, there will be a huge bill to pay, and that bill can only be paid as the result of increased—and greatly increased—production.

—*Professor R. D. WATT.*

The Water Hyacinth.

By EWEN MACKINNON, B.A., B.Sc.

THE WATER HYACINTH—*Eichhornia speciosa* (Kunth) (= *Pontederia crassipes* (Mart.)) is a floating representative of a small order of plants known as the *Pontederiaceae*, named in honour of Pontedera, a professor of botany at Padua, 200 years ago. There is only one species of this order native in Northern Australia and Queensland, but none in New South Wales or Victoria. Our plant, like many more of the plant pests of Australia—notably, Prickly Pear, the Lantana, and the Cape Weed—is an introduced species, and has been distributed from Queensland into New South Wales and Victoria. Its native home is Guiana, in

THE WATER HYACINTH.

South America, the whole order consisting of aquatic and marshy plants distributed throughout the warm parts of the world. Such introduced plants often become far greater pests in their new situations than in their native habitats. They escape from the old ecological factors which have brought about a state of equilibrium; and, finding the new conditions favorable, develop to such an extent as to become a nuisance. In their new environment they will come naturally into a new struggle for existence, resulting finally in a new balance of nature; but we cannot afford to wait for this, and man becomes a new and necessary factor in their control. The water hyacinth, however, has not failed to make its presence felt in its own home, and in some parts of Guiana it is as great a pest as anywhere else in the world. Though called a hyacinth, it is

not included in the same order as the true Hyacinth, which belongs to the *Liliaceæ*, a large order comprising plants such as the Lily, true Hyacinth, Tulip, Asparagus, Onion, and Aloe. It derives its name chiefly from the resemblance of the simple spike of six to twelve flowers of a pale-purple colour to that of the true Hyacinth, but differs in being an aquatic plant. Its flowers are borne on a short stiff stem 6 to 12 inches long with several sheathery bracts at the base. (See Plate.) The upper petal is larger than the other five, and is marked by a yellow spot in a cloud of blue. The leaves are somewhat rounded, but very variable. Their stalks are just as variable in length, and the lower half is inflated, more especially in the young leaves. These swellings, which are filled with air and act as floats for the whole plant, gradually disappear as the leaves become older, until the stems become nearly equal in thickness throughout, or taper from the base to the leaf blade. The leaves form a rosette from 1 to 2 feet high, and this remains above the water as the plant floats. The roots hang freely in the water, or attach themselves to the mud in the more shallow water of water-courses and lakes. The roots may penetrate to a depth of 2 to 4 feet, but the plant may thrive just as well in fairly deep water. The plant flowers freely, producing abundance of seed, which ripens and falls between the leaves of the parent plant, and, coming in contact with the water, soon germinates. As the older plants mature they are gradually forced below the surface of the water by the younger generation, and an ever-increasing thickness of matted vegetation is produced. The amount of air in the cellular tissue of the floats is often sufficiently buoyant to enable one to walk about on the surface of a mass of weed as if on a raft. In shallow water-courses and in lagoons it is only a matter of a few years until they are filled up with a mass of decomposing vegetable matter. Besides its propagation by a profuse development of seed there is normally a propagation by stolons, which in tropical waters is very rapid and effective. Stolons branch out from an old stem, extend from 4 to 8 inches from the parent plant, and form on their ends a little rosette of leaves. Roots spring from the node where the rosette is formed, and the young plant soon becomes self-supporting. Old plants will usually be found to have formed several (three to five, or more) stolons which branch out in different directions. Several generations of plants produced in this way will frequently be found connected by the old stolons, which are often about half-an-inch in diameter, and are very strong. As plants commonly grow close together, the newly developed offshoots bind the mass firmly together, so that it is difficult to separate the individual plants. It thus forms compact masses which frequently cover acres of waterways and lagoons, blocking navigation. Boats, punts, droghers, and small steamers often find it impossible to penetrate such growths.

Distribution.

The historical accounts of its introduction into various centres where it is now a serious pest are very much a repetition of one another. The plant is an attractive one with its green bulbous leaves and its handsome pale-lavender flowers, and is frequently grown in green-houses, or in the home in a pot of water. It is from such apparently innocent sources that it soon becomes spread round the neighbouring water-courses and ponds. In a U.S.A. Bulletin, Bureau of Plant Industry, No. 18, Dr. Webber gives an interesting account of its introduction into the St. John's River, Florida, in 1890. It was grown in a pond, which was afterwards cleaned out, and the material thrown into the river near by, and thence it spread to all the lower streams. In many cases this was aided by admirers of the plant, who had no idea of its possible spread and damage. They placed plants in the river near their own homes to beautify the surroundings. In 1894 it was so plentiful as to attract the serious attention of steam boatmen and fishermen, and after severe storms and floods in the same year it was found to be very abundant. Similar is the story of its introduction to the northern rivers of New South Wales. About twenty years ago a resident of Swan Creek, 4 miles below Grafton, purchased a specimen in Brisbane, and later on threw it into the creek near by. It thrived so well that in two years it took possession of the creek, which there is 50 yards wide, and from 10 to 35 feet deep.

It killed out the blue flowered water lily, *Nymphæa stellata*, which used to exist there in great abundance.

At the present time it is to be found growing luxuriantly on the Clarence and Richmond Rivers and their tributaries, and also in smaller quantities on the Tweed and Macleay.

It very early became a pest in the Bremer River, near Ipswich, Queensland, and during floods and freshes large areas of many acres were discharged into the Brisbane River, threatening danger to navigation and damage to the bridges by collecting flood *débris* above these structures. In Queensland it obtained a hold in the western rivers, and also became a pest in the lagoons in the Rockhampton district. It was introduced into the Wagga district, New South Wales, as

RICHMOND RIVER (N.S.W.) SHOWING HYACINTH.

early as 1895, and rapidly spread, covering about 7½ acres, or half of the Wollondry Lagoon. The growth was removed in 1900 by men in a boat at a cost of about £8. There is great danger of its spread to the sluggish fresh water rivers like those of western New South Wales—Murray-Darling system—the channels and divides of places like the Yanco irrigation canal. It has taken possession of drains and larger channels cut in swamp reclamation projects, *e.g.*, at Alumny Creek.

CORAKI BRIDGE CLEAR OF HYACINTH.

There are three useful factors which operate to prevent its spread too far—

1. It is killed by salt water.
2. It is very susceptible to cold.
3. It does not live on dry land at all.

1. It is very intolerant of salt, and soon dies out in the tidal waters of rivers, even though masses continue to float down the stream from the fresh water above. Salting the plant has been suggested as a method of checking its development.

2. Moderate cold checks it, and moderate frost injures or kills it. Hence it does not flourish much further south than the north coastal rivers in New South Wales unless we go inland.

3. The usual method of clearing away the weed is to drag it out and heap it on dry land, where it will soon rot; but on account of the large amount of water it contains it will live for some time, and care should be taken to place it where it will not be knocked back again into the water by animals, or by heavy rains.

It is found that a current of about 4 miles an hour is rapid enough to carry the growth away. Still the plant is often found growing in the bends of rapidly running streams, and in Emigrant Creek, a stream entering the Richmond a few miles above its outlet, the Hyacinth is abundant in a rapidly running stream, but protected by growths of the giant reed, *Arundo phragmites*. It is doubtful whether floods will eradicate growths like this.

It is likely to prove dangerous only in the warmer parts of Victoria, where it might become a serious pest in irrigation channels, lakes, and water-courses. The spread of the plant should be carefully watched, as it is a fact well proved that plants can become acclimatized to the new conditions, more especially with respect to temperatures, at which growth will take place. In other parts of the world Water Hyacinth has become as great a pest as in Florida and Australia, and much attention has been devoted to various ways of combating it either by utilization or destruction.

It was introduced into Indo-China twenty years ago, and at first its flowers were sold in the streets. It has now become a serious pest, resulting in much legislation being passed to secure its destruction.

Similarly, in Burmah, there is the Water Hyacinth Act, No. 1, 1917, providing for the destruction of the plant and all its parts.

In Tonkin its appearance dates from 1902, Cochin China 1904, and in 1906 it was unknown in Cambodia, but in five years it had become an insurmountable obstacle to navigation, and in 1916 was present in all the smallest water-courses, as well as in large central lakes. The natives throw down planks on it to cross the water-ways.

It also occurs in Java and Japan, and the Federated Malay States.

The rate at which it grows has been a matter of careful observation, and a single root has in a few months covered a space of 600 square metres.

In addition to blocking navigation along creeks and water-ways there are two other aspects worthy of note—

1. In periods of drought the only green feed and water available are in these creeks, and the weed soon becomes eaten near the edges. Cattle seeking further relief have to descend steep banks, and in stretching out to reach the remaining green weed frequently slip in, and, being too weak to recover, are drowned if help is not soon forthcoming. Many head of stock are thus annually lost, and in one district of the Clarence River some sixty to seventy head of cattle were drowned in one year.
2. On many farms of the North Coast the only supply of water for farm stock is obtained from lagoons, creeks, or blind water-courses. When the Hyacinth becomes well-established in these areas the water is rendered unfit for drinking purposes. The decomposing plants give off most offensive smells, the water becomes inky black and putrid, and stock will not touch it. It is in such places as these that the weed is often difficult to eradicate, but in the creeks it can be cleared.

Attempts at Utilization.

Many experiments have been carried out in all infested countries to discover some profitable way of utilizing the pest. It is not recommended as a manure for direct application, as it is very bulky to handle, rots quickly, and does not provide much humus. It has only a very slight and temporary value.

As a fodder it is eaten by pigs and cattle, but is not relished except in times of scarcity or drought.

At St. John's, in Florida, cattle and hogs eat the weed in winter time, and here and elsewhere it is also eaten by stock. An analysis was made to determine its feeding value with the following result:—

WATER HYACINTH.—Report New South Wales Legislative Assembly, 1906. (Burrows, Maiden, and Guthrie.)

Water	90.17 per cent.
Ash	1.42 per cent.
Fibres	1.33 per cent.
Albuminoids	1.75 per cent.
Sugar and other carbohydrates	5.10 per cent.
Ether extract (fat or oil)	0.23 per cent.
	100.0

Nutritive value, 7.36.
Albuminoid ratio, 1 to 3.2.

The amount of indigestible fibrous matter is much lower than one would be led to expect from the appearance of the leaf and stem. It contains apparently no injurious properties, and from the chemical analysis has a definite feeding value, with a composition not unlike succulent roots such as turnips, mangels, &c.

Some authorities state that it is not of much value for cows, and useless for sheep and horses.

Attempts to use it for commercial purposes have not been very successful.

One proposal was to use it as a raw material for making paper cardboard and paper felt, for engine-packing and insulation purposes, and for upholstery. Material was submitted by the New South Wales Agricultural Department to two paper manufacturers, who reported as follows:—

1. No use for making paper or cardboard, as no fibre present.
2. Unsuitable for anything except strawboard, and for that purpose sufficient cheap material is already at hand at 10s. a ton and cartage.

A third reported that it might be used for paper, but would have to be cleaned. All threads and knots would have to be removed.

It was also submitted to four firms of upholsterers, who replied—

1. Might be used in one of the cheapest lines of upholstering, but would have to be marketed at a cheap rate.

The other three condemned it on the following grounds:—

2. Does not contain sufficient body.
3. In testing it would be all reduced to dust.
4. Owing to dust workmen would refuse to handle it.

A leading paper manufacturer in England, to whom specimens were sent, reported that it was the most inferior substance yet offered to him. The amount of fibre was only 4 per cent.

—*Agricultural Gazette*, New South Wales, 24/712.

Interesting tests were also made in Cochin China. (Reports by Mr. J. B. Suttor, from the Director of Agriculture):—

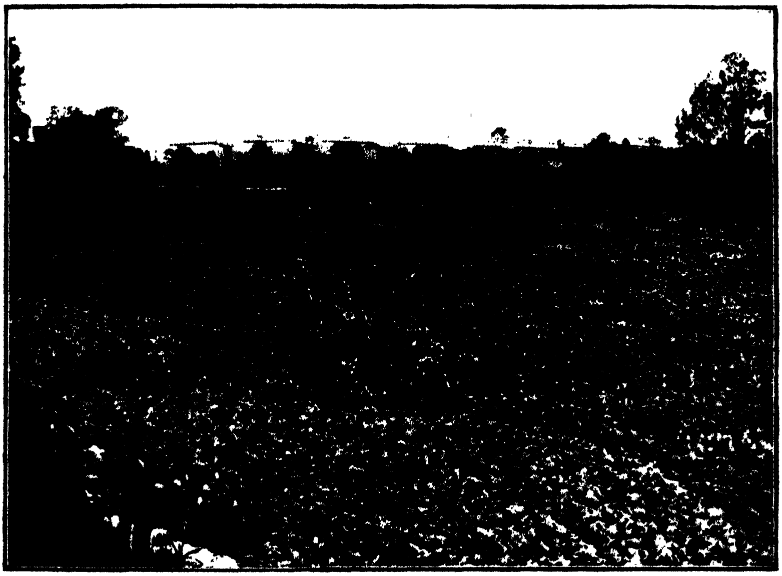
"The only use so far found for it was to convert it into manure by allowing it to decompose in heaps on the banks, and subsequently spread it out in the fields. The residue from these heaps is a mould (?) rich in potash and nitrogen."

An experiment was made to convert it into wicker chairs, but it was found to be an unsuitable material. A similar result was obtained from the manufacture of bags and mats. These, after a time, became mouldy, and though continually dried the fibre was found either to absorb or else to retain a large amount of moisture. It was also found to be more expensive than gunnybags, and two or three times heavier.

The results of experiments in ropemaking were not encouraging, as the fibre does not possess resistance, and rotted and deteriorated very rapidly when exposed. In obtaining the fibres, it was found that drying in the sun fermented it, so drying in the shade became necessary. Favorable reports as to its value

in clothmaking, at first supplied by Mr. Suttor from Cochin China, were not supported by later practical tests. The breaking strain of a rope 5 mm. diam. and 1 metre long was given as 49 kilos., and the elongation as from 10 cm. (The percentage of fibre is less than that of prickly pear.)

It will be evident from these experiments, many of which have been carried out with exceptionally cheap labour (Chinese in Cambodia), that any successful utilization of water hyacinth as a source of raw material for manufacture in the arts does not seem feasible. Greater success seems likely to be achieved from the use of the plant as a source of potash.



RICHMOND RIVER (N.S.W.) COVERED WITH WATER HYACINTH.

Probably the most extensive and reliable analyses have been made in the Federated Malay States, and the following figures are taken from *Agricultural Bulletin*, April and May, 1918:—

SUN-DRIED PLANT.

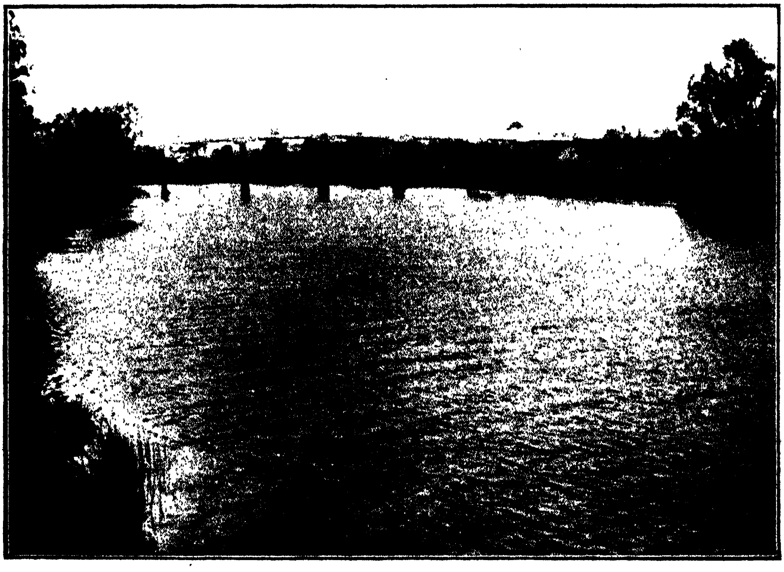
	Mean of 10 Sets.	Roots.	Large Stalks and Leafy matter.
	Per cent.	Per cent.	Per cent.
Moisture	11·4	..	..
Organic Matter	61·0	..	..
Total Ash	27·6	33·3	10·5
Water soluble	4·6	15·3	9·3
Water insoluble; Acid soluble	9·6	7·4	1·2
Insoluble	13·4	10·6	Nil.
Total Potash K_2O	3·64	1·3	2·7
Water + Weak Acid soluble	2·93	1·1	..
Soluble in water alone	..	..	2·7
Phosphorus as P_2O_5	0·61	0·8	0·3

The ten results for total ash and total potash were, approximately, as follows, in percentage:—

Ash, 38, 25, 36, 11, 21, 36, 29, 15, 35, 31. Mean = 27.6.
K_2O., 2, 2.6, 3.7, 2.6, 3.1, 5, 5.5, 3.9, 4.4. Mean = 3.64.

Analysis of the Ash.

	Mean of 10 Ashes.	Roots.	Large Stalks and Leafy matter.
	Per cent.	Per cent.	Per cent.
Chlorides extracted with hot water, as Cl. ..	8·7	..	..
Sulphates as $So._3$	13·0	..	..
Solubility—			
Water only	20·1	46·0	88·5
Acid	36·9	22·4	11·3
Insoluble	43·0	31·6	0·2
Potash. Total (K_2O)	15·3	3·9	25·8
Water, Soluble only	..	3·2	25·7
Water + Weak Acid, soluble	12·7	..	..
Phosphorus (P_2O_5)	2·8	2·2	2·9



SAME SCENE SHOWING RIVER FREE OF HYACINTH.

The ten results of potash were, approximately, as follows, in percentage, and also percentages of water plus weak acid soluble in second row:—

Total K_2O 5.3, 10.5, 10.3, 25.1, 14.7, 14.0, 18.8, 26.0, 12.9

Soluble 2.2, 7.7, 4.6, 25.1, 12.7, 11.7, 15.4, 25.8, 9.7, 11.8

The most important result of this work has been to show that the variable composition of the plant in respect to the potash content given by Finlow and McLean, in India (*Journal of Agriculture*, India, July 1917), is due to the different amounts of ash contained in the plant, and that this variability is due to the presence of fine particles of silt, &c., adhering to the roots of the plant, and, therefore, to some extent adventitious. In all cases in which the ash content is high, the potash content of the ash is low, and *vice versâ*. The lowest percentage of ash was obtained from samples mostly composed of stalks. To ascertain whether the potash salts could be easily washed out of the sun-dried plants, hot water extracts were made, and after determining the amount of chlorine in these, the whole material was added together, evaporated, and ignited. The ash was twice extracted with water and re-ignited to secure a complete combustion. Both potash and phosphates were determined. The ash is very high—mean 27.6 per cent. The lowest from stalks, 10.5 per cent.; next, larger

light-coloured stalks, red ash, 15 per cent.; well developed roots, 21 per cent. Other plants seldom exceed 20 per cent. of ash, *e.g.*, tobacco, 12 to 16 per cent.; grasses, 7 per cent.; oak, 1.3 per cent.; beech, .6 per cent. It was found that the whole of the potash of the stalks was present in an easily soluble form—probably as a chloride—an important fact for the potash recovery on a commercial scale. If the soluble potash is expressed as a chloride (KCl), the percentage so obtained is equal to the percentage of readily soluble ash, *i.e.*, the bulk of the potassium is present as the chloride. (*See* second table, last column.)

When plants are freed from roots and all extraneous matter, there is from 10 to 15 per cent. of ash, and more than three-quarters of this ash is readily soluble in water.

Nearly all the phosphate present is in a soluble form. The percentage of potash in the ash is not high. Few uncultivated plants yield large amounts of ash rich in potash. As a comparison, the percentage of K_2O derived from ashes of various plants is as follows:—

Tobacco, 30 to 40 per cent.; bamboo (a source of potash in Burmah), 30 to 40 per cent.; banana, 40 to 50 per cent.; beech tree, 25 per cent.; oak, 11 per cent.; coconut husks, 15 to 20 per cent.

The preparation of commercially pure soluble salts of potassium merely requires burning, lixiviation, and fractional crystallization—three simple operations particularly adapted to our climate.

When we consider that the bulk of the world's supply of potash salts is located in Germany, and that many countries are experimenting with expensive chemical processes for the preparation of potash from felspars and felspathic rocks, the preparation of potash salts from water hyacinth seems an attractive commercial prospect. In the *Journal of Agriculture of India*, July, 1917, the position is summed up thus: "The value of the green plant as a nitrogenous, phosphatic, and potassic manure is apparent—its use as such resolves itself into a question of transport, as 95 per cent. consists of water." An inventor of a process for extracting potash from water hyacinth has already made application for a patent in New South Wales to exploit the weed on the Richmond and Clarence Rivers and tributaries. The inventor claims the following results:—

Air-dried plants yield 17.37 per cent. ash. This 17.37 per cent. ash contains 13.71 per cent. total potash; or 17.37 per cent. ash contains 10.60 per cent. soluble potash.

30,000 tons air-dried water hyacinth yield about 1,500 tons of 30 per cent. potash (K_2O), which is a marketable commodity, and was valued at about £11 per ton before the war.

These results are rather less than the mean of the Malay results, *e.g.*—

Ash, mean, from sun-dried plants, 27 per cent. (10 to 15 per cent. from plants freed from roots). This 27 per cent. contains 15 per cent. total potash; or 27 per cent. contains 12.7 per cent. soluble potash.

We may take it that about 3 per cent. of the dried plant is potash (K_2O). We must beware, however, of basing all calculations and preparations on laboratory determinations. The ash obtained by a complete burn on a small scale may differ somewhat from that likely to be obtained in an actual pit burn on a much larger scale; and there is bound to be loss owing to imperfect means of extraction and preparation. A large percentage of the costs will be due to the collection and preparation of material before burning. This will have to be satisfactorily solved by the introduction of mechanical methods of cutting up the weed in thick extensive areas, collecting, crushing, and delivering it in sufficient quantities in proper condition at the place for burning. Further, as the roots contain very little potash, but a large amount of ash and extraneous matter, some method of cutting the plant, or if pulled from the mud, of cutting off the roots, would reduce the after-handling charges. In all probability, in small plants, some kind of power engine—possibly the alcohol type—might be used for the operation of travelling conveyors and rollers for crushing, &c., and the exhaust heat be used in the processes of drying and evaporating.

These experimental investigations presupposes an ample supply of the plants. This, no doubt, exists already in many of our creeks and water-ways, but the need for destruction in many places will still exist.

The methods that have been either tried, or proposed, are as numerous as the various attempts at utilization. They might be classified into Biological, Chemical, and Mechanical.

Biological methods usually involve the introduction of some plant or insect pest. There is a leaf-spot disease that kills the whole leaf of the water hyacinth, and is widely distributed. This might be of service as a continuous method of destruction, and its introduction should be easily accomplished. The native home of the pest is usually explored to discover any natural controls; but we are not likely to meet very much success with this method, other than the leaf-spot fungus, as the water hyacinth is a very serious pest in its own country. There does not appear to be any insect pest of any value as a destructive agent of water hyacinth. The introduction of another weed—or water pest—*Philotria canadensis*, has been suggested; but the cure may turn out to be as bad as the disease.

Under *Chemical* methods, there may be mentioned chiefly the use of copper sulphate, arsenic compounds, and kerosene or gasoline. The use of poisons is usually fraught with too much risk to animal life, as the strength of the solutions that would be required to kill the weed would be sufficiently strong to kill animals that might drink the water (cattle, horses, &c.), and also birds and fish, and probably other vegetation as well as the hyacinth. As the plant produces an abundance of flowers and seed, a large amount of control could certainly be obtained by the use of a poisonous spray at the time of the pollination of the flowers. No doubt, the use of some of the deadly "liquid fire" sprays used in the war could be cheaply applied to the destruction of the flowers, if not to other parts. The following up of any mechanical means of eradication by the search for and destruction of all young plants developing from seed is necessary for the complete success of any eradication process; hence, any method that will prevent the wholesale production of seed must be of great value, especially if combined with some effective mechanical means of destruction. The use of an arsenical solution (Harvester Compound) from barges fitted with sprays and pumps, was experimented with years ago in Florida; but the cost was found to be excessive—£4 per acre—as compared with various mechanical methods, *e.g.*, in Queensland, 30s. an acre.

It is considered that the removal of the plant by mechanical means would be the most economical that could be adopted, and this may then be followed by the process of potash extraction from the removed plants.

The most successful form of mechanical destructor appears to consist of some form of punt or barge fitted with a stern paddle-wheel, having a double bow or outriggers, which, being forced into a mass of weeds, would cause them to gather towards the centre of the boat. Here an inclined carrier, consisting of an endless travelling band, with a flap set below the water's edge, would convey the weed to rollers where it would be crushed, and the mat delivered by the same means into a barge alongside. Cutting devices of a mechanical nature have also been suggested for operating in thick masses of the weed.

On the Clarence and Tweed Rivers, it is a common occurrence for the wire ropes of ferry punts to be broken by the down-stream pressure of great masses of the weed, and a common method of getting rid of the plant is to place a floating barrier across the river until a great area of weed collects, then either to drag the mass on to the land or float it down to the salt water. Such methods, are, however, only spasmodic, and much money has been spent by shires and municipalities in periodic attacks, which bring about only temporary relief. Systematic and concerted action will be necessary to clear definite areas, but the utilization of the plant for potash production may convert large areas of what is now a nuisance into a valuable asset.

The details of a process for the recovery of the potash salts on a commercial scale (taken from Malay States' *Bulletin*, VI., 312), will serve as a conclusion to this general summary of the present vexed question of the water hyacinth, in the hope that further experiments will be undertaken along the lines indicated above.

THE WATER HYACINTH.

The plants should be cut off from the roots. Drying should be carried out quickly, and in such a manner as to facilitate draining. The well-dried stalks should be burned in pits dug in the earth in places sheltered from the wind. The collected ash—about 12 per cent. of dried plants—is spread out on a cement floor, sprinkled with water, and worked through till it is evenly damped. Experience will show whether a little lime should be added, as probably this would keep the phosphate in the residue. The damp ash is placed in a cask provided with a false bottom covered with dried grass or leaves, and water preferably hot, is poured over it. After standing some time in the sun, the liquor formed is drawn off from a plughole at the bottom. When it reaches a specific gravity of about 1.16, it can be evaporated down at once, the weaker liquors and washings being used for lixiviating fresh ash. The residue, which will still contain some potash, is a good manure, and if the prosphate remains, is practically as good for local use as the original ash. This process is suitable for work on a small scale in scattered places, while the purification, if needed, could be done in central establishments.

Natural Science is a subject which a man cannot learn by paying for teachers. He must teach it himself, by patient observation, by patient common sense. And if the poor man is not the rich man's equal in those qualities, it must be his own fault, not his purse's.

CHARLES KINGSLEY.

Braxy: A Sheep Disease and Some Generalities.

By Prof. W. J. DAKIN, D.Sc., F.L.S., F.Z.S.*

During the last three or four years the farmers and pastoralists of certain districts in Western Australia have been faced with mysterious losses amongst their sheep. At first the trouble attracted little attention, but unfortunately it gradually increased in intensity. During the last two years it has been a matter for considerable discussion, and goodness knows how many theories have been brought forward to account for it. Many correspondents to the newspapers never seem to examine their sick or dead animals before taking up pen and writing off to the editor of this or that journal. Others, again, have neither lived in nor even visited the stricken districts. But this sort of thing is not exactly confined to problems associated with sheep.

The disease (if it is a true disease at all) appeared to resemble a sheep disease termed braxy. The writer of this article, when commencing his own investigations, endeavoured to find out whether it really was braxy; now, as a result, he is wondering whether any one knows what braxy is. Yet braxy has been diagnosed in most of the Australian States, and has only lately been notified as occurring in South Australia. It is noteworthy that in some cases in Australia a sheep disease has been termed a braxy-like disease, only. Perhaps a certain amount of doubt was felt by the recorder. One needs to be quite certain on every ground before a characteristically North European disease is scheduled for Australia. Whether doubt existed in the various investigators' minds or not, it certainly exists in mine at present, for I do not understand exactly what features are to be taken as characteristic of braxy. I will expound this at greater length in a moment. Before doing so, let me point out a fact which seems to me rather extraordinary—perhaps because it is only recently that I have been interested in sheep disease. Take up most works on veterinary anatomy and therapeutics, and you will find that the sheep occupies a very subordinate position indeed. Attention has been focused on the horse, the cow, and dog. The fact is, sheep, unless stud sheep, are not of much value individually, and have not counted for so much to the veterinary surgeon. They are, however, of great value collectively. The pastoral industry is the most important in Australia, and in 1916 the total value of the pastoral production was £89,940,000. Of this, about 80 per cent. represented sheep products. If the pig paid the " rint " in Ireland, the sheep is doing so in this country. How much money is being spent on the investigation of sheep diseases? If losses were negligible, one might suggest leaving that work to countries where sheep diseases were prevalent. Losses are, however, not negligible in Australia. According to Dr. Dodds, of Sydney, a braxy-like disease alone in New South Wales is responsible at present for losses approaching £400,000 annually. A similar disease is responsible for considerable losses in Victoria and Tasmania, but I have no actual figures by me. The losses due to a braxy-like disease in Western Australia only run into thousands of pounds, and the trouble is still rather local compared with the great extent of pastoral country in the State. To the above must be added the losses due to blow-fly, to liver fluke, and to other worm parasites infecting parts of the different States.

* Professor of Biology in the University of Western Australia.

Now let us look a little more closely at this disease known as braxy. It appears to be something entirely confined to the sheep, and was named and studied first in Northern Europe. In Germany, Denmark, Norway, and Iceland the disease is called bradsot. A study of the derivation of these words would be interesting, but out of place here. Bradsot appears to mean "sudden sickness." The disease seems to have been known in very early times, but it is difficult to place much reliance on the rather general descriptions referring to it. It is supposed, however, to have been first established and entailing severe losses in Scotland at the end of the eighteenth century and beginning of the nineteenth, when sheep-farming practically only began in certain districts. The first scientific work on the disease in question was that of a Norwegian Government veterinary officer, Ivan Nielsen, in 1888, and he is supposed to have discovered a bacterium which was the cause of the disease. Further work has been carried out since by the Norwegian Government and by others, but we will confine our attention to that of a Royal Commission appointed by the British Government in 1901 to look into the matter. A voluminous report of the work of this Committee was published in 1906, and, reading it, one would almost take it for granted that this was the last word on braxy. Most veterinary text-books seem to have regarded it in this light. Yet the disease still comes up for discussion every now and again in Europe. (Meissner, Mitt. d. Inst. f. Landw. in Bromberg, 1909; Titze and Weichel, Jour. Comp. Path., 1911; and others.) The position of affairs seems to me to be somewhat as follows:—Sheep die under certain circumstances, the symptoms and *post-mortem* conditions being very like or almost exactly the same as those enumerated by Hamilton in his Royal Commission Report. The disease is apparently braxy, *but*, there is another feature which should be present, and is of the greatest importance, *i.e.*, *the cause*.

In the report of the Royal Commission occurs the statement:—"Putrefaction appears to set in the moment the animal dies, *and is caused by the braxy bacillus*. . . . Even days after the death of the animal, *the peritoneal liquid may be found to contain an almost pure culture of the braxy organism*."

Now, if an investigator finds that he cannot isolate the above-mentioned bacterium, he doubts either (1) that he has a case of braxy before him, or (2) that the cause of braxy is really a bacterium at all. Never having seen a case of braxy in Europe, I am unable to add anything as to the cause of the typical disease. I *do* doubt, however, a great deal of the so-called braxy in Australia, and its reputed cause. I have also two criticisms to urge against the Royal Commission's report, a report which, to some extent, seems to have stayed further investigation. The first is that it does not seem the proper thing to conclude that a bacterium taken from a putrefying sheep is the cause of its death, because, *inoculated* into another sheep, it produces a like result. It seems rather natural that a bacterium isolated at a *post-mortem* examination some hours after death should kill other sheep when inoculated subcutaneously. The second criticism is that little or no attention seems to have been paid to the possibility of other than bacterial causes of braxy.

Braxy is, to my mind, little more than a name for a group of clinical and *post-mortem* features, and more than one actual cause may provoke

them. With regard to the so-called braxy-like diseases in Australia, I have come to the same conclusion as Dr. Dodds, *i.e.*, that further research is necessary before concluding that they are the result of a braxy type of bacillus. Sheep diseases in Australia require urgent investigation, and that investigation, in many cases, will have to mean a great deal more than the recognition of death as due to this or that disease of Europe or elsewhere. Up to the present, with certain excellent exceptions, there has been too much dependence on the work of other countries which may not apply here, and some of the stuff printed for farmers is worse than out of date. I have in mind a weird article on Sarcosporidiosis, which I have seen somewhere.

Let me conclude with a little extract from the Royal Commission report, which I have more than once referred to. It was published thirteen years ago, but still holds good:—

"The side issues which have cropped up show how little the diseases to which sheep are liable are understood—how much, in fact, they are misunderstood—and what necessity there is for more extended and trustworthy knowledge of their nature and cause. From a pathological point of view, they are a perfect mine of wealth, are fraught with scientific problems of the highest interest and importance, and are most suggestive of what may turn out to be a new light on the pathology of many of the contagious and infectious diseases of man and the lower animals."

I should suggest that any arrangement fostered by the Commonwealth Advisory Council of Science and Industry for the better study of sheep diseases and parasites should be correlated with existing University laboratories in the different Australian States. The Universities provide greater freedom for the enthusiastic research worker than other institutions, and they, for their own good, must be brought into closer contact with industrial matters. As a matter of fact, if the science departments I have known become "academic" and "unpractical," it will be because they were not allowed to be anything else; it will not be from a matter of choice.

Scientific thought does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.

—*W. K. CLIFFORD.*

Engineering Standardisation.

By GERALD LIGHTFOOT, M.A.

From the very beginning of the movement to establish the Institute of Science and Industry it has been intended that the Institute should actively concern itself in the work of standardisation. Thus in the report of the original conference convened by the Prime Minister (the Right Honorable W. M. Hughes, P.C., K.C.) in January, 1916, when the scheme of work and organization of the Institute was first formulated, it was stated that—"The highly specialized intricate work of standardising electrical instruments and other scientific apparatus for use as sub-standards . . . . would also naturally fall within the functions of the Institute." In a later report made by the Executive Committee of the Institute to the Government in July, 1917, the importance of standardising work was emphasized, and it was recommended that the laboratories to be established for research work should include one for testing and standardising purposes.

Though no further steps for establishing such a laboratory can be taken until the Bill to establish the permanent Institute is passed, a large amount of information has been collected both from published documents and by personal interviews with experts regarding the work and organization of standardising institutions in other countries, and the probable requirements of Australia in connexion with this class of work has received close attention. The information collected shows that a vast amount of standardising work of the greatest value and importance to the engineering industry has been carried out in other countries, notably in Great Britain and the United States of America, and that organizations for engineering standardisation have recently been, or are now being, established in many parts of the world.

The importance and extent of the progress made in the above direction do not appear to be adequately or generally appreciated in this country. Several factors, including the keen commercial and industrial competition arising out of the war, the demands of labour for a higher standard of living, and the importance of stimulating industrial enterprise make it now more important than ever that Australian industries should introduce modern order and system into all their methods of production. If this is to be accomplished individualistic methods must give way, where practicable, to co-ordination and collective effort. It is, in fact, co-operation that will give the highest value to individualistic effort. If through some representative and authoritative central body, producers and users of engineering materials will agree to accept standard specifications, the community interests of buyer and seller will be realized, the quality of the materials will be improved, and their cost diminished, while at the same time a higher degree of efficiency will be secured in the engineering and other industries.

Perhaps the most notable step in the realization of engineering standardisation was taken in 1841, when Sir Joseph Whitworth introduced the standard screw-thread. When urging the necessity for standardisation he illustrated his argument by mentioning that candles and candle-sticks were in use in almost every house, and that nothing

would be more convenient than for the candles to fit properly into the sockets of the candle-sticks, which they seldom did. The lesson taught by this illustration lies at the root of standardisation.

Standardisation is now generally recognised as being of paramount importance to economic production. Its primary objects are to cheapen manufacture by elimination of waste entailed in producing a multiplicity of qualities and designs for one and the same purpose, to effect improvement in quality, design, and workmanship, to increase production, to reduce maintenance charges and variety of stock, and to secure interchangeability of parts.

From the producers' point of view the two ultimate objects of standardisation are greater output and reduced cost. Obviously a machine continuously producing an article of standardised type or design will have a very much larger output than would be the case if it were necessary to change the tools or dies to meet various specifications, and if this principle were applied to the whole of the machinery in a large works, the production would be enormously increased. Moreover, standardisation itself facilitates the adoption of improved processes and types of machinery. For example, only a plant such as Ford's could find profitable use for multiple drills which bore dozens of holes into both the top and the sides of several cylinder castings at the same time.

As regards economy in labour, standardisation leads to specialisation in workmanship. In a multiple product factory there may not be enough work of the same kind to keep one man engaged constantly on that work, therefore he is required not only to change his work from time to time, but to be capable of performing several kinds of operations. Apart from the effect in such cases in decreasing the output, greater skill is ordinarily required in a multiple product factory. In a standardised product factory the workmen perform one operation practically continuously and become highly expert at it, so with the aid of automatic machinery a man may operate a number of machines at once. It follows, therefore, that with the same capital cost and plant, and with the same expenditure on wages, a factory can produce many more units of standardised product than its competitor manufacturing multiple products. The cost is still further reduced when the overhead expenses are taken into consideration. The two advantages mentioned are by no means the only advantages resulting from standardisation from the producers' point of view, but all the others lead back to these two, mass production and diminished cost per unit product.

From the consumers' point of view the main advantages of standardisation are also twofold, viz., reduction in cost and improvement in quality. Reference has already been made to the former. As regards the latter, it has been found in other countries that one of the most important results of standardised specifications is generally to increase the quality of the product. The objection is sometimes taken that standardisation tends towards crystallization, and thus interferes with progress; but experience has shown that standardisation does not lower the standard, but, if anything, tends to raise it. Standardisation reflects in effect the consensus of opinion as to what constitutes the

best modern practice, with the result that those manufacturers who, prior to the adoption of standards, were producing an inferior article, have to increase the quality or design if they desire to conform to the generally accepted standards. Standards are revised periodically, so as to keep pace with technological progress. This is all to the advantage of the consumers, who obtain a high-grade standard article, and can do so merely by reference to the accepted standard specification. This tends to eliminate disputes, and to simplify the preparation and enforcement of contracts.

The supreme value of standardisation from the point of view of mass production and economy in cost was strongly emphasized during the war. The maintenance of an adequate supply of munitions of war was possible only as the result of standardisation and specialization, while in regard to civilian clothes and various other materials the exigencies of economical production necessitated the adoption of standardised methods. It is obvious that if in normal times the standardisation of any considerable number of articles and products could be effected, while at the same time making sufficient allowance for individual variations in style and taste, there would be an enormous increase in the efficiency of production, accompanied by a corresponding decrease in cost.

Though screw-threads were standardised in 1841 very little further progress in engineering standardisation was made until the beginning of the present century. The International Association for Testing Materials had its origin in a conference of a small group of engineers held at Munich in 1882. Meetings on a larger scale were subsequently held, and the International Association was formally established at a congress held at Zurich in 1895. The seventh congress which was to have been held at Petrograd in 1915 was suspended on account of the war. The objects of the Association, as set forth in its by-laws, are:—"The development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for the purpose." The subject of standard specifications has also been included with the scope of the Association's activity. Its total membership, representing 31 countries, before the war was 2,769. The work of the Association is carried out partly by International Committees and partly by individual members.

The American Society for Testing Materials was established in 1898 for the purpose of promoting knowledge of the materials of engineering and the standardisation of specifications and methods of testing. It is now an organization of the highest importance with a membership of 2,200, comprising practically all the leading engineers of the United States. It is strongly supported by engineering associations and societies, by large corporations and by manufacturers and users throughout the country, while the technical and scientific Departments of the Federal Government, such as the Bureau of Chemistry, the Bureau of Mines, the Forest Products Laboratory, the Bureau of Standards, and the Federal Arsenal all closely co-operate in its work. The Society is controlled by an Executive Committee consisting of

eighteen members. The preparation of the standard specifications is carried out by Standing Committees and Sub-Committees, the members of which consist generally of equal numbers of producers and users. Membership may be held by individuals, firms, corporations, technical or scientific societies, teaching faculties and libraries. The standards adopted covers 132 engineering materials, whilst there are also 49 materials for which tentative standards have been drawn up, but not yet finally adopted. The materials for which standard specifications are in force are divided into four groups, viz.:—(*a*) Ferrous metals, such as steel rails, structural steel, spring steel, tubes and pipe, steel castings, &c.; (*b*) Non-ferrous metals, such as pure metals in ingot form, white metals, aluminium alloys, &c.; (*c*) Cement, lime, gypsum and clay products; (*d*) Miscellaneous materials, such as paints, varnishes, shellac, road and paving materials, insulating materials, &c.

The British Engineering Standards Association was established in 1901, at the instance of the Institution of Civil Engineers, and a far-reaching organization has now been developed consisting of some 170 Sectional Committees, Sub-committees, and Panel Committees, including in all over 900 members, and dealing under one central authority with standards relating to practically the whole field of engineering materials. The Main Committee consists of 24 members, of which 19 are nominated by the leading engineering institutions and two by the Federation of British Industries, the remaining three being elected in view of their eminence in the engineering profession. The Sectional Committees consist of technical officers of Government Departments, consulting engineers, manufacturers, contractors, users and representatives of the technical societies and trade organizations concerned. They decide the broad lines upon which the specifications are to be drawn up, leaving the detailed work of drafting to Sub-committees, which in turn may intrust the preparatory work to expert Panel Committees. The funds for the work are not provided by members' subscriptions, as in the case of the American Society for Testing Materials, but are furnished by subscriptions from the British, Indian, and Dominions Governments, from engineering, railway, shipping and other companies, and from Local Government Boards and tramway and electricity authorities. The Association has a registered mark or brand, which has come very widely into use.

Although the activities of the British Engineering Standards Association have in the main been confined to the home country, a considerable amount of work of an international character has been undertaken, and steps have recently been taken to create standardising committees in a number of countries, including India, Canada, South Africa, Brazil, China, Chile, Peru, Spain, Uruguay, and the Argentine. In Japan the question of engineering standardisation has been actively taken up, and special attention has been directed to the standardisation of ships and ship-building materials.

There is no statutory provision for enforcing the adoption of the standards, but their common use is generally effected through the influence and strength of the standardising organizations. Official and semi-official authorities ordinarily require that materials used by them

must conform to the standard specifications, and this, of course, has an important influence in bringing about the general adoption of the standards.

In contrast with the progress made in certain other countries, practically nothing has been done in Australia with respect to engineering standardisation. With few exceptions, there is a multiplicity of standards in some cases, and an absence of standards in others. The existing state of affairs is a burden on both manufacturers and consumers. It causes loss of time, waste of effort, inconvenience to manufacturers, and increased cost to users, and in some cases seriously hampers industrial development. A single example will suffice. In the Commonwealth there are at least eight specifications for cement used, respectively, by various Railway Departments, Public Works Departments, Harbor Trusts, and other public bodies. In the opinion of experts there is no reason why a single standard specification should not be adopted in Australia, the specification providing, where necessary, for certain variations in the tests with which the material must comply according to the purpose for which it is to be used, *e.g.*, whether for ferro-concrete work, fresh-water or sea-water.

As regards the work of engineering standardisation in Australia, the Institute of Science and Industry does not in any way desire to carry out this work itself. It is believed, however, that the organization is more likely to be successfully established if the movement is initiated by some Commonwealth body which is entirely free from State or sectional interests. It is thought, moreover, that the movement is of such fundamental importance to the efficient development and organization of our industries, that it should be accorded the moral and financial support of the Commonwealth Government, which is, of course, a large consumer of many of the engineering materials for which it is proposed that standard specifications shall be prepared. The Institute, therefore, desires to provide the organization, and to otherwise assist the engineers of Australia to do the work for themselves through their Associations and Societies.

There is, moreover, another consideration of fundamental importance which necessitates that the national Government should actively concern itself in the standardisation movement. Scientific research work upon problems connected with standardisation is a necessity. This work is based upon the modern view that quality depends upon definite measurable or determinable properties, and it therefore requires access to standard measuring apparatus and facilities. Scientific problems are, in fact, constantly arising in all lines of standardisation work. For example, scarcely a problem can be taken up concerning the specification of standards or properties of materials that does not involve chemical analysis or the co-operation and advice of chemical experts. Fortunately, in the work of preparing standard specifications for Australia there will already be available the results of the very valuable work already completed in other countries, and it may be that in this country it will be practicable to adopt, possibly with no or little modification, some of the standards devised in other countries. Nevertheless, it is probable that in certain classes of engineering materials, such for

example as paints and varnishes, scientific research work will be necessary before standards can be laid down suited to Australian climatic and other conditions and to Australian raw materials.

In considering the question of organization, it is important, in the first place, to bear in mind that standardisation cannot be attained by one section of the community endeavouring to impose its opinions on other sections, but only by co-operative action on the part of all concerned. Effective agreement as to standard specifications can only be arrived at by common consent of all the parties interested, who take full part in the discussions and in the initiating and working out of the actual details of the specifications.

The Institute of Science and Industry has already, at the request of certain authorities and persons interested, arranged for representative conferences to be held with a view to arriving at an agreement in regard to standard specifications for structural steel sections, railway rails, and fish-plates, and tramway rails, respectively. These conferences have already been held with entirely successful results. The action taken by the Institute in respect to these matters does not in any way affect the proposal to establish a Commonwealth Engineering Standards Association to take up the whole work, but it was considered undesirable to postpone action in regard to the three matters mentioned until the Association is established. The results already achieved by the three conferences afford a valuable illustration of the importance and possibilities of the movement.

Towards the end of 1918 the Institute arranged, through its State Committees, for representative conferences of engineers to be held in the capital town of each State, with a view to focusing attention on the subject of engineering standardisation, and to enlisting the sympathy and support of persons interested. At each of these conferences resolutions were unanimously passed strongly supporting the movement, which has thus already been approved, not only by individual leading engineers throughout the Commonwealth, but also by practically all the Engineering Societies and the Commonwealth and State Governments Departments concerned.*

The Institute now intends to send a representative to visit each State with a view to establishing in the Commonwealth an organization somewhat on the lines of the British Engineering Standards Association.† It is proposed that the Commonwealth Government, through the Institute of Science and Industry, should assist in establishing and carrying on the work of the Association, and should formally appoint the members of the Main Committee. It is thought that this arrangement is desirable for several reasons. In the first place, it appears probable that by far the greater part of the necessary funds will have to be provided by the Commonwealth Government. Secondly, the Engineering Associations and Societies in Australia are not generally organized on a Federal basis, and the individual associations and

* A summarized account of the proceedings at these conferences was given in *Science and Industry*, No. 1, page 50.

† A pamphlet on Engineering Standardisation, which includes an outline of the organization proposed, has recently been published by the Institute.

societies have not the same national status or scope as that of the institutes which control the standardising movement in England. In view of the conditions obtaining in Australia, it is not likely that the engineering associations and societies will themselves establish a standardising organization, at any rate, in the near future.

Moreover, the engineering industry in Australia has not yet reached, from the manufacturers' point of view, the same stage of development as in Great Britain or the United States of America, and it would appear to be quite impracticable to establish in Australia an organization like the American Society for Testing Materials, which has a large membership behind it, and which is financed mainly by members' subscriptions.

In conclusion, it cannot be too strongly emphasized that, whatever scheme of organization be adopted, mutual concession and the sinking of sectional interests and individual opinions are necessary as a condition precedent to any effective agreements being reached in the work of standardisation.

Personal.

Mr. H. W. GEPP, INDUSTRIAL SCIENTIST.

It is perhaps too early at this stage to predict the future of the many new industries in Australia which owe their birth to the war. Most of these "war babies" are still in their swaddling clothes. Others of them have shot forward with amazing rapidity, and have become vigorous and robust children. Conspicuous for its quick and strong development is the zinc industry, which already has passed out of its infancy and is establishing a home circle of its own with quite a number of dependants. Zinc oxide and lithophone for the manufacture of paints and pigments, and rolled zinc for various purposes, are some of the off-springs. Caustic soda and various chloride products will shortly be added to the family group. From babyhood to manhood in less than three years is, therefore, the record of the zinc industry in Australia. At the present time, its production gives employment to 600 men in the works at Risdon, near Hobart, and this number it is expected will, in the near future, be doubled.

To this development Australia is largely indebted to Mr. H. W. Gepp, the General Manager of the Electrolytic Zinc Company of Australasia Proprietary Limited. Prior to the outbreak of war, the manufacture of zinc by the distillation process was practically the monopoly of Germany and Belgium. Great Britain was largely dependent upon those two countries for her supplies. Canada and the United States, however, produced small quantities, and the enormously increased demand occasioned by the munition necessities had to be met by purchases from across the Atlantic. Naturally, enormously increased prices had to be paid. Zinc soared from about £20 per ton to about £140 per ton, and America was largely benefiting. Mr. Gepp, who was in the United States in 1915 and 1916, on the business of the Amalgamated Zinc Company, made a close study of the developments in the industry, and then determined upon making investigations into the practicability of treating the concentrates in Australia. The first consideration was the obtaining of cheap power. This was found to be available in Tasmania. Mr. Gepp then spent a considerable time in working out various processes, and eventually advised the Australian companies to consider the advisability of the treatment of the raw material locally by the electrolytic process. Upon his return to Australia, accompanied by a number of American experts, he selected a site near Hobart for the proposed plant.

Since the beginning of 1918, the plant at Risdon has been producing about 5,000 tons of zinc per annum. Plans are now in hand to extend the plant to produce between 35,000 and 45,000 tons of zinc per annum, together with the development of a number of subsidiary industries. The utilization of these concentrates in Australia, containing approximately 30 per cent. of sulphur, will mean the gradual but steady elimination of imported brimstone and pyrites for acid manufacture for the production of superphosphates, which are so essential for farming industries. The company proposes to treat about 100,000 tons of Broken Hill concentrates annually, which will represent the

utilization in Australia of 22,500 tons of sulphur annually, equivalent to the production of 255,000 tons of superphosphate, working in this regard in connexion with various superphosphate plants already established on the southern coasts of Australia.

Apart from the direct value to the Commonwealth of Mr. Gepp's visit to America three or four years ago, great strides have been taken towards making the British Empire self-contained in the production of one of its vital requirements.

Mr. Gepp is a brilliant metallurgical chemist, an engineer of considerable attainments, and a leader of men. The huge plant at Risdon did not come into existence merely as the result of his scientific research. One difficulty after another presented itself when the erection of the plant was commenced, and it was due as much to his unwearying perseverance, his capacity for organization, and the confidence with which he was able to inspire those who were associated with him, that the various obstacles were overcome. In spite of the fact that some of the difficulties at first appeared insuperable, the plant was got going within nine months.

Mr. Gepp is an Australian, having been born in Adelaide, and has been connected with the metal industries of Australia for the last twelve or thirteen years, when, at the age of 29, he went to Broken Hill as an officer of the Zinc Corporation to erect an acid plant in connexion with their flotation process. Prior to this, he had held the position of manager of the Australian Explosives and Chemical Works, a responsibility which he had gained at the early age of 23. Commencing as a cadet upon leaving school in that company's works, he also attended lectures in chemistry at the Melbourne University in his spare hours, studying under Professor Masson. Three years later, he was sent for further experience to Nobel's Explosives, at Stevington, near Glasgow, where he studied the manufacture of high explosives, both for munition and commercial purposes, interesting himself particularly in the making of acids, and of gun-cotton, cordite, and various other propellants. His first duty upon his return to Victoria was the control of the erection of large extensions to the equipment at Deer Park, including plant for the manufacture of superphosphate and other fertilizers.

Upon becoming associated with the Broken Hill interests, Mr. Gepp moved quickly from one important post to another. In 1907, he was offered, and accepted, the position of manager of the De Bavay Treatment Company, and was for some time engaged in the development of the De Bavay process for the winning of sulphides from Broken Hill tailings. He retained the position of manager when later this company was extended and floated into the Amalgamated Zinc De Bavay's Limited. Under his supervision, the large flotation plant at Broken Hill for the treatment of tailings from various mines was carried out.

Since the introduction of the flotation processes—of which the De Bavay is one—Broken Hill has been responsible for the production of between 400,000 and 500,000 tons annually of zinc concentrates, and a smaller proportion of lead concentrates. On full production, the plant of the Amalgamated Zinc Company has produced 150,000 tons annually of concentrates, treating up to 2,000 tons a day.

In 1911, Mr. Gepp was sent to England by the Amalgamated Zinc Company in conjunction with the Broken Hill South and Broken Hill North, to investigate various processes for the treatment of slimes, of which large accumulations had gathered at Broken Hill. The solution of this problem, however, was eventually produced in Australia by the introduction of the differential flotation process.

In 1914, after being in camp for some months assisting in training field engineers for the Front, he went to America in connexion with business for Amalgamated Zinc Limited, his intention being to remain only a few months, but was retained there for quite a period in connexion with various metal and munition matters.

During the latter part of 1916, after investigating the possibilities of production of zinc by the electrolytic process, Mr. Gepp was authorized by his company to take the necessary steps to demonstrate that enormous quantities of zinc concentrates available at Broken Hill, representing a quantity of 200,000 tons annually of metallic zinc, could be satisfactorily utilized for the production of high grade zinc; and carried out some tests on a fair-sized scale in America, and returned at the end of 1916 to Australia.

Ever since Mr. Gepp's visit to Europe in 1911 and 1912, he has been deeply interested in the development of the right attitude of mind and the right spirit between all classes of the community in connexion with industrial work, whether this work be in connexion with the production of steel or other metals, or with any other branch of industry. In this regard, he recently remarked:—"I have felt very strongly that we cannot hope for reasonable efficiency, reasonable happiness, contentment, and health in the community without the leaders of industry taking a definite and clear attitude of helping to educate the country generally as well as educating themselves. The work, which has been followed up in specific cases by those of us who think as I do, has demonstrated that, just as the Australian soldier can fight well as long as he is led well, so Australians generally will work well as long as they are taken into the confidence of the leader and that everybody plays the game. It is only by definite co-operation and clear thinking, and by endeavours to reduce the wastage, such as in the case of distribution of essential commodities and bringing down the cost of living and improving the conditions of home life, that we can hope for reasonable results in the future."

Among the visitors to the offices of the Institute last month were Mr. Seizamburo Shimizu, the Consul-General for Japan, and Mr. K. Tamaki, who is Acting Consul-General during Mr. Shimizu's visit to Japan.

Mr. A. McKinstry, B.A., M.Sc., a member of the Executive Committee of the Advisory Council, and one of the Victorian Electricity Commissioners, has been granted six months' leave of absence. He sailed for England by the *Marathon* on July 12.

Professor T. H. Laby has secured six months' leave of absence from the Senate of the Melbourne University on account of ill-health, and will visit England. Professor Laby is a member of the Victorian State Committee of the Advisory Council.

PERSONAL.

Mr. A. Montgomery, Chief Mining Engineer of Western Australia, and a member of the Advisory Council of Science and Industry, recently paid a visit to the head office of the Institute in Melbourne.

Mr. F. H. Taylor, entomologist, has severed his connexion with the Queensland Blowfly Committee of the Institute.

Mr. H. W. Gepp, of the Executive Committee, is making a brief visit to the United States. He is the third member of the Executive who has gone to America recently.

Mr. Lane Poole, after all, is not forsaking the West for Victoria. He writes:—"No, I am sticking to the West, which, with the exception of Tasmania, is the State most urgently in need of a forest policy."

To the natural philosopher, there is no natural object unimportant or trifling. From the least of Nature's works he may learn the greatest lessons.

—SIR JOHN HERSCHEL.

REVIEWS.

THE CATTLE TICK IN AUSTRALIA.

A new Bulletin, No. 13 (40 pages), on "The Cattle Tick in Australia," has been issued by the Institute of Science and Industry, and replaces No. 1, which is now out of print. It contains all the essential matter of No. 1, but brings the information on the subject up-to-date. No less than six appendices are included, which summarise the recommendations, reports, and results of various Commissions, Conferences, and investigations since 1916. A coloured plate well illustrates all the stages in the life history of the tick.

The text carefully distinguishes between two forms of tick affection—(1) Tick Infestation or Tick Worry, due to the worrying attacks of a few thousand ticks biting the animal, probably injecting a toxin, and sucking the blood. Various forms of inflammation, ulceration, and gangrene may be produced, with accompanying symptoms of fever, anæmia, and exhaustion. This appears to be the most prevalent form of tick trouble in Queensland. Horses at pasture also suffer from this form. (2) Tick Fever, due to the transmission, chiefly by the larval tick, of a protozoan known as Babesia (commonly called Piroplasma) bigemina.

An historical account, with two maps, briefly describes the introduction and spread of the tick itself in Australia. It reached Australia in Asiatic cattle imported from Batavia 1872, and spread east to Queensland, and west to Western Australia, reaching Derby 1916. It reached Glencoe, Queensland, 1880-81; Longreach, 1895; east to Brisbane, 1899. It was kept out of New South Wales until 1906, when it crossed at Tweed Heads and reached as far as Kyogle in 1909. There were two isolated outbreaks of tick fever in New South Wales in 1916 and 1917. It thus occurs from Kimberley district, Western Australia, round the north of Australia, through Queensland to the Richmond River.

Next in order follow an account of tick fever and the life history of the tick.

Tick fever, known by various names—Red Water (Australia, Britain, Canada), Bovine Malaria (Europe), Tristeza (South America), is a specific disease of cattle caused by a protozoan parasite, which passes part of its life in the tick, and part in the red blood corpuscles of cattle. The influence of factors like age, sex, condition, season, &c., upon the symptoms of tick fever has long been recognised. Calves are proof against it; adult bulls very susceptible. The fever is most acute in summer, and dry seasons accentuate the mortality.

The various symptoms are carefully enumerated, and methods of treatment and protection discussed.

After recovery from an attack, there appears to be a degree of protection. Protective inoculation rapidly affords protection (sixth day), but the duration and degree are subject to variation, and depend largely on the animal. Inoculation is extensively used in Queensland, but has not yet been found necessary in New South Wales.

The Tick—*Margaropus* (*Boophilus*) *australis*, is stated to be a different species from the Texas Fever tick *M.* (*B.*) *annulatus*. The mature female falls to the ground, and lays its eggs after a time of rest (two to ten days summer, two to three weeks winter). She may lay up to 5,000 eggs. These hatch to the important stage, known as the larval tick or "seed tick," which has only three pairs of legs. It is this larval stage that mostly transmits the parasite of tick fever, having been infected through the egg from the adult female. The parasitism is so perfect that the larval tick now requires its particular host, otherwise it dies, though it may live as long as six or eight months (American results). We shall not follow it through its various moults to adult, but pass on to one of the most striking chapters, which gives some estimate of the enormous loss caused by the tick. These are treated under such heads as mortality, diminished leather value, meat production, and milk yield, money expended in controlling and eradication, loss on secondary industries, depreciation of land, &c.

We find that from mortality there is over £500,000 loss a year. In Queensland, the depreciation in leather value is as much as £100,000 a year. Depreciation of milk supply varies from 18 to 40 per cent. The costs of control work for New South Wales for five years were £123,000. If the enormous toll of the tick pest could be expressed in figures, the total amount involved would stagger the community. In the United States of America, it is estimated that the annual loss varies from £8,000,000 to £20,000,000.

The concluding section outlines the general methods in use for eradication. The tick may be attacked either during its existence on the pastures or during its parasitic development on its host. The second is the one adopted here, and the methods that can be used are:—

(1) Hand-picking and grooming; (2) Hand-dressing and spraying; (3) Dipping.

The most expeditious and efficacious method is dipping. It is the only practical method of treating unhandled cattle and horses. Arsenic is the most reliable tick-destroying agent, and there are several official formulæ. The results so far achieved, and the legislative Acts adopted in United States of America, New South Wales, Queensland, and Western Australia are described.

When we consider that in 1906 there were 750,000 square miles of the United States of America under quarantine, and up to 1912 a total of 163,000 square miles were cleared; and that during the war no less than 150,000 square miles were cleared in 1917-18; that the cattle of Mississippi increased from 86,000 in 1914 to 156,000 in 1916; and that now only 270,000 square miles of territory in the United States of America remain to be cleaned, it is to be hoped Australia will awake to the possibilities of clearing out such a pest, adopting some motto like that of the southern United States of America ("A Tick-free South in 1923"), and endeavour to act up to it.

1917-18.

THE PARLIAMENT OF THE COMMONWEALTH.

A BILL

FOR

AN ACT

Relating to the Commonwealth Institute of Science and Industry.

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, as follows:—

PART I.—PRELIMINARY.

Short title. 1. This Act may be cited as the *Institute of Science and Industry Act* 1918.

Parts. 2. This Act is divided into Parts as follows:—

Part I.—Preliminary.

Part II.—The Commonwealth Institute of Science and Industry.

Part III.—The State Advisory Councils of Science and Industry.

Part IV.—Powers and Functions of the Directors.

Part V.—Miscellaneous.

Definitions. 3. In this Act, unless the contrary intention appears—

"Advisory Council" means an Advisory Council of Science and Industry established under this Act;

"Director" means a Director of the Commonwealth Institute of Science and Industry;

"Institute" means the Commonwealth Institute of Science and Industry;

"Officer" means any person employed by the Directors under this Act;

"The Minister" means the Minister of State administering this Act.

PART II.—THE COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

4.—(1.) There shall be a Commonwealth Institute of Science and Industry which shall consist of three Directors and in each State an Advisory Council of Science and Industry. It shall be a body corporate with perpetual succession and a common seal and capable of suing and being sued. The Institute of Science and Industry.

(2.) All Courts, Judges and persons acting judicially shall take judicial notice of the seal of the Institute affixed to any document or notice, and shall presume that it was duly affixed.

(3.) The Institute shall, subject to this Act, have power to hold lands, tenements and hereditaments, goods, chattels and any other property for the purpose of and subject to this Act.

(4.) The Institute shall have power to acquire by gift, grant, bequest or devise, any such property for the purposes of this Act, and, in the absolute discretion of the Directors, to agree to any conditions of such gift, grant, bequest or devise.

(5.) The powers of the Institute under the last preceding sub-section shall, subject to the regulations and the approval of the Minister, be exercised by the Directors on behalf of the Institute.

5.—(1.) The Governor-General may appoint three persons to be Directors, of whom two shall be chosen on account of scientific attainments. Appointment of Directors.

(2.) On the happening of any vacancy in the office of Director the Governor-General shall appoint a person to the vacant office.

(3.) The term for which any such appointment is made shall be five years, and every person so appointed shall, at the expiration of his term of office, be eligible for re-appointment.

(4.) In case of the illness, suspension or absence of any Director, the Governor-General may appoint a person to act as Deputy-Director during the illness, suspension or absence, and the Deputy shall, while so acting, have all the powers and perform all the duties of a Director.

6.—(1.) The Governor-General may appoint one of the three Directors to be Chairman of the Directors, and on the happening of any vacancy in the office of Chairman of Directors the Governor-General shall appoint a person to fill that office. The Chairman of Directors.

(2.) In case of the illness, suspension or absence of the Chairman of Directors, the Governor-General shall appoint one of the other Directors to act as Chairman during the illness, suspension or absence.

7.—(1.) Each Director shall receive such salary as the Governor-General determines. Salaries and expenses of Directors.

(2.) The salaries of the Directors shall be paid out of moneys appropriated by Parliament for the purpose.

(3.) Travelling expenses as prescribed shall be paid to each Director on account of his expenses in travelling in the discharge of the duties of his office.

Suspension of Director.

8.—(1.) The Minister may at any time suspend a Director from his office for incapacity, incompetence or misbehaviour.

(2.) If a Director is so suspended the Governor-General may appoint a Board of Inquiry (consisting of three persons, one of whom shall be the Chairman of the Board, and any two of whom may exercise all the powers of the Board) for investigation and report upon the charge of incapacity, incompetence or misbehaviour preferred by the Minister.

(3.) If the Director does not admit the truth of the charge preferred against him, the Board of Inquiry shall inquire into the truth of the charge, and, after fully hearing the case, shall report to the Governor-General their opinion thereon.

(4.) If the charge is admitted or is found by the Board of Inquiry to be proved, the Governor-General may, if he thinks fit, call upon the Director to retire from his office, and he shall retire accordingly.

(5.) If the charge is found by the Board of Inquiry not to be proved, the suspension shall be immediately removed by the Minister.

(6.) Save as in this section provided, a Director shall not be removed from office during the term for which he was appointed.

Quorum of Directors.

9.—(1.) For the conduct of business any two Directors shall be a quorum, and shall have, subject to sub-section (3.) of this section, all the powers of the Institute.

(2.) At a meeting of the Directors the decision of the majority shall prevail.

(3.) If, at any meeting of the Directors at which only two Directors are present those Directors differ in opinion upon any matter, the determination of the matter shall be postponed until all the Directors are present.

Directors to devote whole time to their duties.

10. The Directors shall devote the whole of their time to the performance of their duties, and no Director shall accept or hold any paid employment outside the duties of his office as a Director or be a director of a company.

Part III.—The State Advisory Councils of Science and Industry.

The Advisory Councils.

11.—(1.) An Advisory Council representing science and the principal primary and secondary industries shall be appointed in each State and shall advise the Directors with respect to the affairs of the Institute.

(2.) The members of the Advisory Council in each State shall be appointed by the Governor-General and shall receive fees and travelling expenses as prescribed for attendance at meetings.

12. One or more of the Directors shall meet and confer with each Advisory Council at least once a year. Directors to confer with Advisory Councils.

PART IV.—POWERS AND FUNCTIONS OF THE DIRECTORS.

13. The powers and functions of the Directors shall, subject to the regulations and to the directions of the Minister, be— Powers and functions of Directors.

(*a*) the initiation and carrying out of scientific researches in connexion with, or for the promotion of, primary or secondary industries in the Commonwealth;

(*b*) the establishment and awarding of industrial research studentships and fellowships;

(*c*) the making of grants in aid of pure scientific research;

(*d*) the recognition or establishment of associations of persons engaged in any industry or industries for the purpose of carrying out industrial scientific research and the co-operation with and the making of grants to such associations when recognised or established;

(*e*) the testing and standardization of scientific apparatus and instruments, and of apparatus, machinery, materials and instruments used in industry;

(*f*) the establishment of a Bureau of Information for the collection and dissemination of information relating to scientific and technical matters; and

(*g*) the collection and dissemination of information regarding industrial welfare and questions relating to the improvement of industrial conditions.

PART V.—MISCELLANEOUS.

14. The Governor-General may arrange with the Governor of any State for any of the following purposes:— Arrangements with States.

(*a*) the utilization for the purposes of this Act of State Research Departments and Laboratories and Experimental Stations and Farms;

(*b*) the co-operation in industrial and scientific research with State Government Departments, Universities and Technical Schools; and

(*c*) the co-operation with educational authorities and scientific societies in the Commonwealth with a view to—

(i) advancing the teaching of science in schools, technical colleges and universities where the teaching is determined by those authorities;

(ii) the training of investigators in pure and applied science, and of technical experts; and

(iii) the training and education of craftsmen and skilled artisans.

Appointment of officers.

15.—(1.) The Governor-General may, on the recommendation of the Minister, appoint such officers as he thinks necessary for the purposes of this Act.

(2.) Officers employed under this Act shall not be subject to the *Commonwealth Public Service Act* 1902-1917, but shall be engaged for such periods and shall be subject to such conditions as are prescribed.

(3.) An officer of the Commonwealth Public Service or of the Public Service of a State who becomes an officer under this Act shall retain all his existing and accruing rights.

Discoveries by officers.

16. All discoveries, inventions and improvements in processes, apparatus and machines made by officers of the Institute shall be vested in the Institute as its sole property and shall be made available under such conditions and payment of such fees or royalties or otherwise as the Governor-General determines.

Bonuses for discoveries by officers.

17.—(1.) The Directors may pay to successful discoverers or inventors working as officers of the Institute or under the auspices of the Institute such bonuses as the Governor-General determines.

(2.) Bonuses payable under this section shall be paid out of moneys appropriated by Parliament for the purpose.

Fees and agreements for special investigations.

18. The Directors may charge such fees and may agree to such conditions as they think fit for special investigations carried out at the request of any authority, institution, association, firm or person.

Annual report of Directors.

19. The Directors shall, once in every year, make a report to the Minister containing a summary of the work done and researches and investigations made and proceedings taken by the Institute during the preceding year.

Reports to be presented to Parliament.

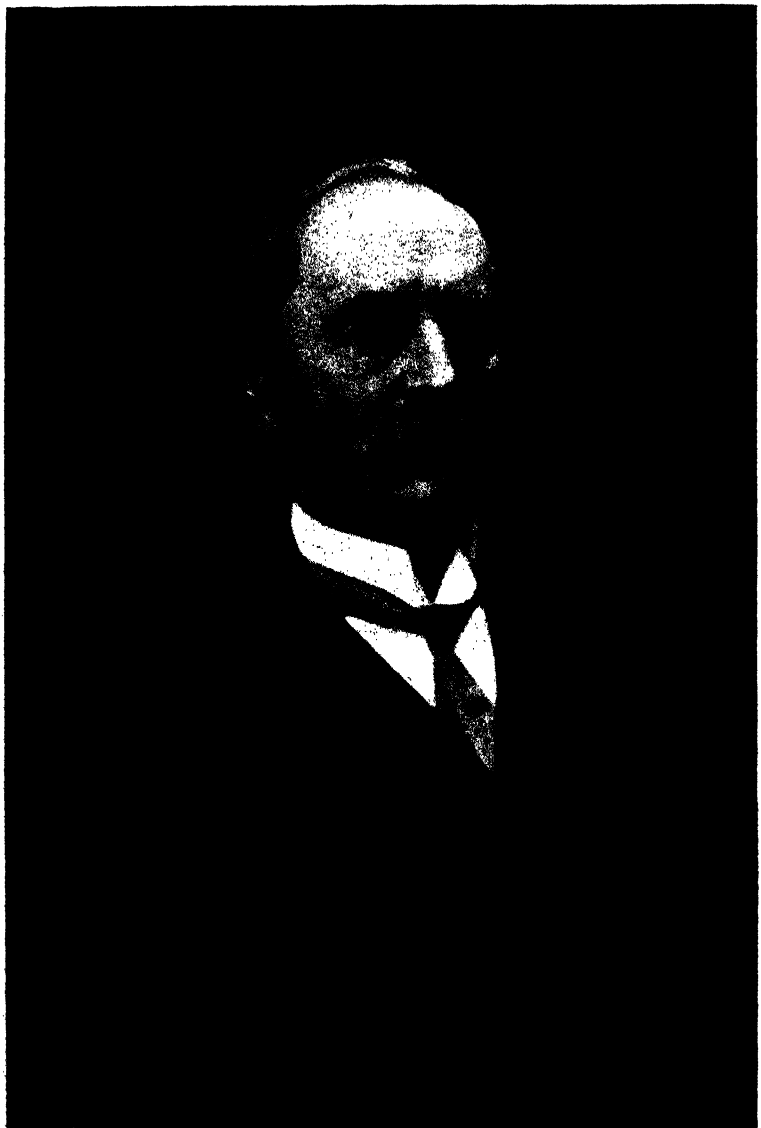
20. The Minister shall cause the yearly report of the Directors to be laid before both Houses of the Parliament within thirty days after the receipt thereof if the Parliament is then sitting, and if not, within thirty days after the next meeting of the Parliament.

Power to publish information.

21. The Directors may publish such information relating to any matter investigated by them as they think fit, except where such publication would be contrary to conditions agreed to under section eighteen hereof.

Regulations.

22. The Governor-General may make regulations, not inconsistent with this Act, prescribing all matters which are required or permitted to be prescribed or which are necessary or convenient to be prescribed for carrying out or giving effect to this Act, and in particular for prescribing such additional powers and duties of the Directors as he deems desirable.



Professor T. R. LYLE, M.A., Sc.D., F.R.S., a Member of the Executive Committee and Chairman of the Victorian Committee of the Advisory Council.

SCIENCE AND INDUSTRY.

VOL. I.] SEPTEMBER, 1919. [No. 5.

EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Cost of the Institute.

During the course of the Science and Industry Bill through Parliament a great deal was heard about cost. Some members seemed to fear that a new Department was being created with unlimited powers of spending the public funds. If this were true it would of course be a very legitimate ground for complaint. But it is not. The Directors cannot spend one penny more of public money than Parliament provides on the recommendation of responsible Ministers of the day. Each financial year the Institute's estimates will come under review in Parliament, and Parliament may accept them, reject them *in toto,* or cut them down as it in its wisdom decides. It may be urged that this is insufficient, that Parliament may in good faith, and with a laudable desire to see Science applied to Industry, appropriate money for this purpose, which the Directors may misuse. Even this is not wholly true, no more true than applying to any other Department of State, for the Institute has a Minister at its head, and he is saddled with the usual Ministerial responsibility to Parliament, which is the basis of our parliamentary system. If this system does not work out entirely satisfactorily in practice, or if it does not altogether please some critics, then the system should be altered, not a particular application of it criticised. But there are other safeguards. The Directors will not be wholly irresponsible individuals whose chief delight is in disbursing public moneys upon chimerical ventures in the wide fields of Science. On

the other hand, they will as fully realize as most the onerous responsibility that rests upon them of getting full value for whatever money they lay out, and they will themselves be judged by results. For their own reputations' sake they will be more careful with the taxpayers' money than with their own. To take a more lax view of their responsibilities would write them down as incompetent for the positions intrusted to them by the Government.

At the same time the Directors should be judged, not by individual cases, but in the mass. When a scientific investigation is entered upon no one can say at the beginning what the result will be, or whether there will be any valuable result at all. If ten researches are entered upon and one is successful, the value of that one discovery may easily recoup the country for the cost of ten times the original ten.

In his inaugural speech, in which he outlined the proposals of the Government to harness Science to Industry, the Prime Minister said that, even if £500,000 were necessary, that sum would be forthcoming. This statement has since been magnified by some critics of the Government into £500,000 "a year." As a matter of fact, what the Prime Minister clearly meant, as shown by the context, was that such a sum would be found as was deemed necessary. What that sum may be no one at this juncture can foresee.

This much is clear, however, that a certain capital expenditure will be essential. National laboratories mean bricks and mortar and up-to-date appliances, and these mean money. The term national laboratories has an indefinite meaning. It certainly does not mean a chemical laboratory only, as some seem to suppose. Chemical work is of paramount importance in connexion with the development of our secondary industries; but as far as the primary industries are concerned, the biological laboratory dealing with both the botanical and zoological sides —that is, plant industry (agriculture), animal industry (stock-raising), is of still greater importance. In the present state of our own development the difficulties that confront the primary producer offer the greatest rewards to the Scientist. He who solves the Prickly Pear problem alone will save this country millions sterling. He who adds a fraction to the average gluten content of our wheat will be a public benefactor for all time. In saying this we have no desire to belittle the difficulties that confront manufacturers. They are great, too, but they are not quite so far-reaching as those indicated. Then, again, there is the laboratory of the Bureau of Standards. There is no use our standardising steel rails and the rest unless we provide a Court of Appeal to which contractors can go and settle their differences should there be a dispute as to quality. This is peculiarly the function of the Bureau of Standards. Then there is the Forest Products Laboratory which has been a crying

need in Australia for years. It is no exaggeration to say that the annual and preventible loss in connexion with our Timber industry would pay the cost of a well-equipped Forest Products Laboratory every year.

But it is neither possible nor desirable that all this should be done at once. A start will have to be made somewhere—the Directors being doubtless guided by the calibre of the men offering who are capable of taking charge. It would be fruitless to erect, say, a biological laboratory if it was not possible to find a suitable biologist to direct its operations, formulate its projects for research, and with infinite patience and exactitude carry them out.

Why should laboratories be erected at all, the critic may ask, seeing that there are already laboratories in existence in each of the Universities and many Schools of Mines, Technical Colleges, Museums, and so forth. It is true that there are scores of laboratories in existence in Australia, but the bulk of them are designed primarily for teaching and not for industrial research—they are controlled by teachers, not generally by researchers. Besides, for the most part, they are quite inadequately equipped and altogether unsuitable, even if they were available for serious research work. Furthermore, the Universities to-day are overcrowded with students. The Professors and their assistants are sadly overworked, and often sadly underpaid. This is very generally realized, and it has been urged that, in view of this fact, the real way to wed science to industry is to enlarge and improve the existing laboratories and not erect new ones. If that were seriously contemplated, it would be the most uneconomical way to go about the matter, and would in practice prove the most ineffectual. It would be far preferable to erect one efficient, well-equipped set of laboratories than tinker with half-a-dozen or more ill-equipped ones. A brand new house is always more comfortable than an old one renovated, and generally costs less in the long run as well. Let those who doubt this try it and prove it.

Now, what is going to be the cost of this scheme of national laboratories? No one can say precisely. A laboratory may involve the cost of, say, £2,000, or it may cost £100,000, or any sum lying between these two. As a matter of fact, the Directors will have to "creep before they gang." The child crawls before it walks—before it finds its feet. So will the Directors begin with small things till they justify themselves and the Institute. They know they will be dependent upon Parliament for money from year to year, and they will not be slow to realize that the easiest way to get money out of Parliament is to prove that the outlay will give a good return to the country. The Directors will be judged on their ability to make science pay. At the same time, it is necessary to realize that in making science pay the

subject should be regarded broadly. On the average science will pay handsomely, but in individual cases no return will be forthcoming. Some problems will be tackled that will prove insolvable, or only capable of solution after years of patient study. It took the Germans over a quarter of a century to apply the stolen notes of an Englishman on the subject of aniline dyes to practical commercial purposes. Then having done so the profits of a single year more than repaid them for those long and costly years which seemed to show a blank. Research work must be regarded on the average, not in detail. If that be done, and if it is insisted that substantial returns be forthcoming for the annual outlay, then it does not matter what is spent. Indeed, the greater the investment the larger the dividend. Already the Institute has more than justified itself for several years to come as the result of the work it has done in standardising steel.

There is one point that cannot be overestimated, and that is that a niggardly appropriation is worse than useless. Suitable buildings constructed and equipped on up-to-date lines, adequate material, and competent researchers are not to be had for nothing; and in this connexion, as in all others, the cheaper they are the nastier they are certain to be. This does not mean extravagance; it means economy and efficiency. Too long has Australia been content with the second best, and has suffered egregiously in consequence. All that need be done is to see that good value is received for the money expended Listen to what that unchallengeable authority, Huxley, says:—

> "I weigh my words when I say that if the nation could purchase a potential Watt, or Davy, or Faraday, at the cost of a hundred thousand pounds down, he would be dirt cheap at the money. It is a mere commonplace and everyday piece of knowledge that what these men did has produced untold millions of wealth, in the narrowest economical sense of the word."

Australia has potential Watts, potential Faradays, potential Huxleys. Let us search round to discover them. In these modern days scientific men for the most part are impotent without apparatus, without up-to-date libraries, in short, without their tools of trade. These must be put into their hands at whatever cost.

F. M. G.

EDITORIAL

WHITE EARTHENWARE INVESTIGATIONS.

Satisfactory progress is being made in the experimental work which was recently instituted at Ballarat, and the protracted preliminary investigations which have already been carried out show beyond doubt that there are great possibilities in the development of the White Earthenware industry. In the past the main trouble has been to ascertain in what proportion the various necessary constituents are to be blended. Clays in new districts differ from those found in the old districts of Europe, and extensive work has to be undertaken to determine the correct proportions, as old formulæ cannot be adopted for new materials. During recent months shafts have been sunk in the Ballan, Lal Lal, and Linto districts, and 1-ton samples of clay from them have been forwarded to the School of Mines at Ballarat. For the manufacture of high grade earthenware, in addition to suitable kaolin, there is required felspar, either in the form of Cornish stone or pure crystalline felspar. Of these materials extensive tests have been made with specimens collected from all parts of Victoria, and occasionally from other States. Considerable success has been met with in this work, as well as in the search for ball clay, which is needed to mix with kaolin in order to give it that elasticity which is essential if it is to be worked on the wheel.

A clay treatment plant is now being erected. It includes a 10-inch filter press, a 10-inch pug mill, and some small ball mills driven by an electric motor. This will enable the work to be proceeded with on something approaching commercial lines.

GOLD INVESTIGATIONS AT BENDIGO.

The third year's work on the above investigations is now completed, and a report on the work is in the printer's hands. At the time of the appointment of Dr. Stillwell as investigator it was thought that a period of not less than three years would be necessary for an adequate discussion of the problems involved. Prominent members of the mining industry and associations connected therewith have closely followed Dr. Stillwell's work throughout, and have recognised that as a result of it a much clearer perspective of the nature of the quartz reefs and gold shoots has been developed, and that his work will have an important bearing in guiding prospecting activities on the Bendigo gold-field. In these opinions the Committee concurs, and considers that the work will be especially valuable when the industry is suffering so severely from unfavorable economic conditions, and consequently is in need of all the technical assistance possible.

The Committee does not recommened the immediate continuation of the work, believing that a reasonable period should be allowed to elapse for the assimilation and practical testing of the conclusions advanced by Dr. Stillwell; but the Committee is of opinion that at a subsequent date it will be found profitable to continue the work which has been financed on a contributory basis by the Institute and by the gold mining companies of Bendigo.

COTTON-GROWING.

The Special Committee in Queensland which is considering the question as to the best methods to be adopted for developing the cotton industry in Australia, has taken up the question vigorously, and has already held three meetings. It has been decided to furnish a report on the following lines:—1. Historical, including Statistics. 2. Possibility of expanding at present, under the heads of—(*a*) Growing, (*b*) Picking, (*c*) Ginning. 3. Protection required. The Committee has accepted the offer made by the Queensland Acclimatisation Society to use the Society's ground at Lawnton for the purpose of growing cotton experimentally, and the construction of an experimental cotton-picking machine is being expedited.

ENGINEERING STANDARDISATION IN U.S.A.

In many lines of engineering great progress had been made before the war in standardisation work in the United States of America. The war emphasized the importance of this work, and showed clearly the need for co-operation to prevent the confusion caused by the promulgation of overlapping standards by independent bodies. It has been found that it is very much more difficult to obtain agreement between the users of overlapping standards after they have been published than it would be to get them to agree before they had committed themselves publicly. The American Society of Civil Engineers, the Institute of Mining Engineers, the Society of Mechanical Engineers, the Institute of Electrical Engineers, and the American Society for Testing Materials, accordingly appointed a Committee to consider the advisability of complete co-operation in engineering standardisation. As a result, the American Engineering Standards Association has recently been established. The governing body of this association consists of three representatives from each of the institutions and societies mentioned, and from each of the following Government Departments—the Department of Commerce, the War Department, and the Navy Department. The main objects of the association are to unify and simplify methods of arriving at standards, and to secure co-operation between the various cognate societies, institutions, and Government Departments concerned. The association hopes, as a result of its work, to give international status to approved American engineering standards. It is also intended that the association shall act as a Bureau of Information regarding standardisation, and that it will establish relations with similar bodies in other countries, with a view to bringing about the acceptance of international standards.

WEDDING SCIENCE TO INDUSTRY.

At a recent Conference held in Sydney under the auspices of the Director of Education, Mr. Peter Board, C.M.G., to consider the question of stimulating the study of science, Dr. R. K. Murphy made the following suggestions:—

To bring about a closer and more efficient co-operation between science and industry it will be necessary—

(1) For the Government to build and equip at the Sydney Technical College an industrial chemistry building, fully equipped with the most modern appliances;

(2) To raise the status of the technical colleges in all respects to that of the best technical Universities of Europe or America, so that we may turn out men of adequate training and ability to maintain and develop our industries to the full utilization of our natural resources;

(3) To immediately make available sufficient money to equip the present industrial laboratory while waiting for the permanent buildings for which this equipment would be available;

(4) To bring about a greater co-operation between the employer, employee, and technical colleges to the end that the employee may receive some daylight instruction and be rewarded in pay for satisfactory progress in his diploma course at the Technical College;

(5) That the education of the boys for preparation to entrance to a diploma course at the Technical College and employment in an industry shall be on as broad lines as possible.

SCIENCE AS APPLIED TO AGRICULTURE.

At the same Conference, Professor Watt moved the following resolutions, which were unanimously agreed to:—

"That this Conference is strongly of opinion that the present is a most opportune time for a bold and comprehensive forward policy of agricultural education and research, and urges that a Conference be convened of representatives of the Agricultural Department, the Education Department, the Public Service Board, and the University of Sydney, to frame such a policy." This policy should include:—

(*a*) Better facilities for the teaching of agriculture in the primary and secondary schools in country districts;

(*b*) The raising of the standard of teaching in existing institutions by increasing the equipment and the staff;

(*c*) Greater encouragement for agricultural teachers and research workers by the payment of higher salaries more in keeping with the enormous importance of their work to the prosperity of the State;

(*d*) Attracting in other ways the best young brains of the country to the study of agricultural and cognate scientific problems."

It was also agreed that the first call on any funds which might be made available by the Federal or State Government for the purpose of research work should be devoted to those subjects which have a direct bearing on the primary producing industries.

The Conference decided to initiate a publicity campaign in the interests of science, and the Chairman, Mr. Peter Board, M.A., intends to call a subsequent meeting to consider the *personnel* of the committee to undertake that work.

NITROGEN REQUIREMENTS OF AUSTRALIA.

During the War the British Government appointed a Nitrogen Products Committee to consider the relative advantages for the Empire of the various methods for the fixation of atmospheric nitrogen from the point of view of both War and Peace purposes. The Institute was requested to prepare a statement as to the probable requirements of Australia in fixed nitrogen both for the manufacture of explosives and for fertilizer purposes. The necessary information has been collected, and a report on the matter is now nearly completed.

COLLIE COAL AND GAS PRODUCTION.

The Western Australian State Mining Engineer, Mr. A. Montgomery, M.A., F.G.S., who is a member of the Western Australian State Committee of the Institute, has issued a report on the subject of Collie coal and gas production. Though Collie coal appears to be rather hopeless as a source of illuminating coal gas made by the ordinary retorting process, Mr. Montgomery states that it by no means follows that it cannot be made available for town illumination by some other process. It has already been used successfully in the Electrical Power-house, Perth, and in the electric lighting of the City of Perth. Leaving this alternative out of consideration, however, there is yet another method by which Collie coal may be utilized as a source of gas for town illumination. In view of the general use of incandescent mantles, the modern requirement is for a good heating gas, not an illuminating gas, and Mr. Montgomery states that for the former purpose Collie coal can be made to serve quite well. To make a heating gas from Collie coal, however, for the purpose of town gas supply, would require a radical alteration in the method of production of the gas, as the retorting process would have to be done away with altogether, and the Mond process, or one of the similar modern methods, would have to be used.

TERRA-COTTA CLAYS AND ASBESTOS IN QUEENSLAND.

The Chief Government Geologist of Queensland, Mr. B. Dunstan, states that numerous inquiries have been made regarding the utilization of the ferruginous clays of the Brisbane district for the manufacture of terra-cotta tiles. A great number of samples of clay have been tested and deposits examined. While some of the material is of first-class quality no large area of workable clays has yet been found. Mr. Dunstan thinks, however, that there is no doubt that deposits suitable for terra-cotta work will ultimately be found not far from Brisbane, where there is a large number of low flat areas in which clays have been formed from the disintegration of the Brisbane schists.

EDITORIAL.

Experiments have recently been made to determine whether Queensland asbestos can be used in place of the foreign asbestos. Much of the asbestos found in Queensland is harsh, woody, and weak in fibre, and quite useless where strength is required, as for example for fibro-cement work. Experiments are, however, being made with powdered Queensland asbestos to ascertain its suitability for use either with Portland cement or with calcined magnesite for floorings and wall linings.

SCIENCE AND INDUSTRY IN QUEENSLAND.

In a lecture given by Professor H. C. Richards, D.Sc., at Brisbane, some interesting illustrations were given of cases in which science had been applied with success to industry in Australia. Professor Richards drew special attention to three scientific investigations of importance to manufacturers in Brisbane. These are:—

1. Utilization of Mangrove Bark for Tanning.
2. The reduction of Ash Content in Coal.
3. Investigation of Clays for Pottery Work.

As regards the first of these, Professor Richards pointed out that before the war large quantities of Australian barks, including mangrove, were used in Germany for making extracts for tanning, which were imported into Australia. The German chemists had solved the problems of decolourization and of the removal of undesirable gummy matter. The Institute of Science and Industry has investigated this matter, and had been successful in devising a process which gets rid of the disagreeable red colour in mangrove bark tanned leather.

The decrease of the ash content of the coal used in Brisbane would be of immense advantage to coal consumers. Considerably more than half the ash in the coal consists of grit, which occurs in bands through the coal, and experiments have shown that a large proportion of this could be removed by coal washing devices. Coal is crushed to about ¼-inch sizes and the dirt and grit separated by gravity, the total cost being usually a matter of a few pence per ton.

An investigation of the clays which are available near Brisbane could be carried out with much advantage. Clays suitable for many purposes are available, and the opportunity of extending the pottery industry should be very favorable.

YEASTS AND BREAD-MAKING.

Valuable progress has been made in the experimental work which is being carried out by the Institute in connexion with the above matter, and the results obtained promise to be of considerable industrial value, especially in connexion with the solution of the day-baking problem. The Special Committee which is supervising the work, and which consists of Professor H. G. Chapman (Sydney University), and Mr. J. Nangle, Director of Technical Education, New South Wales, reports that it has prepared yeasts which ripen doughs weighing 400 lbs. in five hours when used in quantities of about 3 oz. moist. The Committee has carried out a continuous demonstration since 1916 at the School of Bakery, Sydney Technical College, of the practicability of preparing bread in nine hours, *i.e.*, from starting to mix the dough until the bread

leaves the oven, under the ordinary conditions of a bakehouse. The Committee has also carried out a demonstration for nineteen months of the practicability of using a single stock of yeast for the preparation of bread by making each day's yeast with a portion of the previous brew. The conditions under which these results have been achieved have been studied in detail and precise information has been obtained in regard to the constituents of the wort, aeration, and temperature. The work has been carried out by the Institute in co-operation with the New South Wales Department of Education, which provided the necessary apparatus and placed the services of a practical baker at the disposal of the Committee. The experimental work has been carried out by Miss M. M. Lilley.

Two points require further study, and these are now being investigated by the Committee. It is desirable to ascertain why apparently a particular concentration of the sugar present in the yeast liquor is needed, if the yeast is to work rapidly when used in small quantities. Secondly, this yeast keeps for only a few days without deterioration. It is necessary to find means for preserving the yeast in a potent form for a longer period.

COLD STORAGE OF BEEF.

Research work of considerable interest to Australia has been initiated in connexion with the cold storage of beef by the Food Investigation Board appointed by the British Department of Scientific and Industrial Research. The Board has established an expert Committee to investigate the question of the methods in use for preserving meat for human consumption, and especially to consider what improvements are possible in the preservation of beef during its transit from Australia and New Zealand to Great Britain.

It has long been known that, whereas mutton can be frozen without impairing its qualities, beef needs much more careful treatment. Freezing in the ordinary way—that is, by cold air—causes a separation of fluid in the substance of the muscle fibres, with the result that on thawing, unless somewhat elaborate precautions are taken, there is loss of water and soluble constituents, and the texture of meat is impaired. The Committee, therefore, decided to set up an inquiry into the cause of the peculiar sensitiveness of beef to freezing. Is it, for instance, due to the difficulty in abstracting heat from the tissues of so large an animal as the ox, or is it due to the colloidal properties and chemical constitution of the muscle fibres themselves? Is the permeability of the sarcolemma of the muscle fibre of the ox different from that of the sheep?

The answers to questions such as these can be found only in accurate and detailed measurements in a laboratory; they belong to biophysics, and by no means to the least intricate region of that science. The work as a whole is under the general supervision of Professor W. M. Bayliss, F.R.S., the laboratory work being conducted in his laboratory at University College, London, where a special experimental plant for investigations at low temperatures has been installed. For large scale experiments a cold store has been acquired in the north of London. Nothing could better illustrate the wide application of organized research, when the basal problems are not lost sight of, than this work. The

results so far obtained promise not only knowledge immediately useful to the cold storage industry, but also a fundamental contribution to the theory of the colloidal state and a further insight into the distinctive colloid characters of the living substance of the animal and the plant.

COLD STORAGE OF FRUIT AND VEGETABLES.

The Food Investigations Board has also established a Fruit and Vegetables Committee to inquire into the metabolism of fruit and vegetables at low temperatures, and into the use of cold, of gases, and of desiccation for the preservation of fruit and vegetables. Research work is now in progress at two centres, namely, at Cambridge, under Dr. F. F. Blackman, and at the Imperial College of Science and Technology, London, under Professor V. H. Blackman and Professor J. B. Farmer.

The part of the general work on fruit and vegetables taken up at Cambridge may be described as a study of the normal physiology at low temperatures of those parts of plants which are used for food. A second line of work relates to the study of the oxidizing enzymes in fruits which are responsible for the browning of the flesh of ripe fruit.

Work at the Imperial College of Science and Technology has so far been mainly of a preliminary character, and has been confined to a study of apples. The work falls under four heads—the study of the chemical changes occurring during the maturation and storage of the fruit; the study of the effect of various external conditions upon the fungi which cause deterioration of stored fruit; the study of the conditions to which fruit is subjected in cold storage; and the testing of a small refrigerating plant for exact laboratory experiments.

BUREAU OF INFORMATION.

A considerable number of requests for information and advice on scientific and technical matters is being received by the Bureau of Information of the Institute. Among the matters on which such requests have been received recently the following may be mentioned:—

(*a*) *Dyes.*—General information relating to the dyeing of cotton goods.

(*b*) *Egg Albumen.*—Methods of manufacture.

(*c*) *Essential Oils.*—Methods for distillation.

(*d*) *Blast Furnaces.*—Information relating to gas engines utilizing waste gases for operating the blowers for the hot blast.

(*e*) *Foundry Practice.*—Utilization of waste coke and iron.

(*f*) *Tar.*—Standard specifications of tar for roadmaking purposes.

(*g*) *Decolourization of Jam in Tin Containers.*—Causes and remedies.

(*h*) *Containers for dangerous Chemicals.*—Precautions to insure safety.

(*i*) *Gas Masks for Rescue Work in Mines and Factories.*—Information as to suitability of different filtering materials and absorbents.

(*j*) *Manufacture of Baking Powder.*—General information.

(*k*) *Luminous Paints.*—Composition and methods of manufacture.

(*l*) *Boiler Lagging.*—Suitability of various Australian raw materials.

(*m*) *Lime Hydrate.*—Process of manufacture.

(*n*) *Duplicating Paper.*—Method of manufacture.

(*o*) *Flue Dust.*—Analyses and advice as to commericial uses.

STANDARDIZATION IN THE ELECTRICAL INDUSTRY.

The Sub-committee of the Electrical Association of Australia, which is co-operating with the Institute in the above matter, has now made recommendations with regard to the voltage at consumers' terminals and transformer sizes. The Sub-committee first devoted its attention to the question of uniformity in the voltage of alternating current supply, and in 1918 it made a recommendation that the standard frequency should be 50 cycles, provided that a frequency of 25 cycles might be used under special circumstances. The new recommendations are as follow:—

1. Voltage at Consumers' Terminals—

"That the standard voltages at consumers' terminals shall be 230 and 460 volts for a three-wire continuous current supply and 230 volts between the neutral and any phase of a three-phase supply, but in those cases where a lower voltage is justifiable such voltage shall be 115."

2. Transformer sizes—

"That the standard output capacities of transformers shall be 2½, 5, 10, 15, 25, 50, and 100 K.V.A., but that the 2½ and 5 K.V.A. sizes shall be standards for pressures up to but not exceeding 5,000 volts."

SCIENTIFIC LITERATURE IN NEW SOUTH WALES.

A well attended meeting was held last month at the Education Department, Sydney, to discuss the manner in which the usefulness of the Public Library can be extended in connexion with scientific and trade literature. Mr. F. Leverrier, K.C., B.Sc., Chairman of the New South Wales State Committee of the Institute, explained the object of the meeting, and pointed out that both scientific and industrial men are equally interested in the importance of technical literature. A committee, including representatives of the Royal Society of New South Wales and its Industrial Section, the Australian Chemical Institute, the Society of Chemical Industry, and the Sydney Technical College Chemists' Society, was appointed to wait upon the Government to urge the necessity for more commodious library premises and for increasing the grant to the Public Library for the purchase of scientific periodicals

EDITORIAL.

RUST IN WHEAT.

Mr. W. L. Waterhouse, B.Sc., who has been awarded a W. & E. Hall Agricultural Research Fellowship to investigate the problem of rust in wheat, has sailed for England with a view to getting into touch with English and American workers on the subject. The investigational work which Mr. Waterhouse has carried out in New South Wales during the past twelve months has been very encouraging, and has thrown a considerable amount of light on the problem; but the stage has been reached when it was considered desirable to secure the collaboration of other workers on the same subject and to gain an insight into their methods. Mr. Waterhouse has been for some time in touch with the work which is being done in this connexion in the United States of America, and has been astonished at the large amount of attention which is being given in that country to the rust problem.

SHEEP-FLY INVESTIGATION IN NEW SOUTH WALES.

In connexion with the investigations which are being carried out by the Institute on the Sheep-fly problem, the Committee in New South Wales has arranged to resume its field experimental work, which will now be carried out on demonstrational rather than on experimental lines. An area of 10,000 acres in the vicinity of Moree will be marked off in sections, and the Committee's recommendations in regard to the use of the Chalcid wasp parasite, trapping flies, and distribution of carrion, will be systematically put into operation over the whole area, with a view to demonstrating the efficacy of these measures in controlling the pest.

The breeding of the parasites will be carried out at the Glenfield Veterinary Research Station, and they will be distributed from there. The work on the demonstration area will consequently be confined to liberating the parasites and observing the effect, in conjunction with destruction by fly-traps over the whole area. In addition, every effort will be made to destroy all breeding places in the shape of dead animals. At the same time tests will be made of any further specifics or remedies recommended by the Committee. Mr. J. F. Caldwell, a returned soldier, has been appointed as officer-in-charge of the field work.

It is worthy of note that the demand from pastoralists for supplies of Chalcid wasps is well maintained. Very favorable reports of apparently effective work by this parasite continue to be received from various parts of Australia, as well as from New Zealand.

FOREST PRODUCTS IN QUEENSLAND.

In connexion with a suggestion that Queensland should undertake the conversion of waste wood into commercial chemicals, the Queensland Minister for Lands (Mr. Coyne) has stated that wood distillation is only one of the many lines of development in the Government's forest programme. The Forest Service has had the question of wood distillation under consideration for some time past, and data are being accumulated with a view to the initiation of experimental work. Apart from distillation products, Mr. Coyne pointed out that the production of

large supplies of charcoal alone was a commercial proposition. "Our forests contain untold chemical wealth," continued the Minister, "and it remains for the Forest Service to discover and make it available to the community. . . . We are merely on the verge of discovery, and, looking to the future, it behoves the community to aim at conservation of its natural resources lest it kill the goose that lays the golden eggs."

INTERNATIONAL TESTING ASSOCIATION.

A representative Conference was held on the 5th June, 1919, at the Institution of Civil Engineers, London, to consider the question of the formation of a new Association to take the place of the International Association for Testing Materials, which has practically ceased to exist in consequence of the war. The former International Association had its origin in a Conference of a small group of workers in experimental engineering held in Munich in 1882. Its objects as set forth in the by-laws were—"The development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for this purpose." It is now proposed to establish a new Association which will be international in the sense of including representatives of the Allied and neutral nations. The Conference could not agree on fixing any definite time limit during which German representatives should be excluded from the new Association. It was finally decided to leave the matter over for the present, and to establish, in the first place, a British Association which would in due course become part of an International Association.

Professor W. C. Unwin has promised to keep the Institute in touch with any progress made. The Institute is not able for the present to take any active steps in co-operating in the movement, but it is hoped that the proposed Australian Engineering Standardization Association will do so as soon at it is established.

AGRICULTURAL EXPERIMENTS IN QUEENSLAND.

The Institute has received through the Queensland State Committee an offer by the Queensland Acclimatization Society to co-operate in experimental work, especially in the cultivation, hybridization and introduction of new varieties of cotton, flax, and castor oil plants. The Society possesses a freehold property of over 100 acres of land at Lawnton, on the North Pine River, about 15 miles from Brisbane, and the permanent staff consists of Mr. R. W. Peters, Director and Hybridist, and Mr. O. W. Houghton, Propagator. The revenue of the Society from its investments it not sufficient to enable it to carry on without supplementing it from other sources, and this is done by propagating plants for sale. This work, however, encroaches on the time of the staff, so that it has been found impracticable to devote much attention to the more legitimate objects of the Society. With a small assured income, in addition to that already available, the Society would be able to devote a considerable amount of attention to the more scientific side of the work.

The Institute has decided to accept the offer of the Society, and as a beginning has made a grant of £100 in order to enable experimental work on Castor Bean cultivation to be started at once. The work will be carried out under the direction of Mr. R. W. Peters, who was appointed to the position on the recommendation of Professor Bateson, and who possesses exceptional qualifications and has had wide experience in plant breeding and horticultural work.

PAPER PULP FROM BLADY GRASS.

In connexion with the manufacture of paper pulp from Blady Grass which is being carried out by Mr. J. Campbell at Cairns, the Cairns *Post* makes the following statement:—"It takes 3 tons of green blady "grass to manufacture 1 ton of crude pulp, while it takes at least 7 to 8 "tons of cane to make 1 ton of brown sugar. Delivered at the Southern "Paper Mill the pulp is worth at least £21 per ton, a value equal to that "of the 1 ton of sugar. Under present conditions the cost of manufactur- "ing the pulp is greater than that of making the sugar, owing chiefly to "the fact that chemicals are dear, and the machinery and appliances "have not been perfected, but Mr. Campbell can show not only how to "make good use of local crude alkalis, but also how to bring the applica- "tion of his method up to sugar-mill standard, thus greatly decreasing "the cost of manufacture. This would mean that a higher price could be "paid for the grass—in fact, a price equal to that of the sugar cane, "say, £2 per ton green, making a ton of hitherto useless blady grass "(considered a pest and a curse by the cane farmer) growing without "cultivation, equal in value to a ton of the best cultivated sugar cane."

RUSTLESS STEEL.

The process for the manufacture of rustless steel was discovered just prior to the outbreak of the war, and was commandeered by the British Government for use in aeroplane construction and other purposes where strength and durability, combined with rust-resisting qualities, were invaluable. The steel is a Sheffield invention, and the process was discovered largely by accident. A local metallurgist, Mr. Harry Brearly, was experimenting in the armament shop, and he noticed that certain pieces of chrome steel had not suffered from corrosive influences under conditions which would have rusted ordinary steel. He followed up this clue, and what is known as "rustless" or "stainless" steel was eventually worked out.

An analysis of a sample of rustless steel has been made for the Institute by Mr. A. J. Higgin, Metallurgical Laboratory, Melbourne University. The analysis gave the following results:—

Chromium	12.95 per cent.
Silicon	0.27 per cent.
Nickel	0.33 per cent.
Cobalt	trace.
Carbon	0.76 per cent.

No attempt was made to determine the sulphur and phosphorus, as the sample was too small to permit of it. These constituents, however, would only be present in small quantities. The percentage of iron would make up the balance of the 100 parts.

UTILIZING THE "BLACKBOY."

The Western Australian Minister for Industries, Mr. J. Scaddan, thus describes what he saw during a visit to the Rowley Forest Products Company's works at Maylands, near Perth:—

"The company was formed about the end of last year, and it has acquired the patent rights and processes and concessions of the late Mr. Henry Rowley, who for many years devoted his time to investigating the potentialities of the blackboy, kingyia, and zamia. The company has spent something like £3,000 on the plant, consisting of nineteen sets of retorts and furnaces, condensers, receiving tanks, stills, &c., and the works are capable of dealing with 100 tons of blackboy per week. When the factory is in full swing, employment will be given to fifteen men, exclusive of the office and selling staff, and three or four cutters will be employed continuously in supplying raw material from the country. The company is now producing, in a readily marketable form, tars free from harmful acids, tarpaulin dressings, rope tar, and sanitary tars; lacquers—such as Japan black—steam and refrigerating pipe coatings, paints for bedsteads and other ironwork requiring stoving at high temperatures; stains and paints of various grades and colours. Pitches for marine insulating and such-like purposes are also being produced; valuable oils (phenols, benzols, and alcohols) are being distilled from the tar, and a coke of high calorific value remains after the blackboy has been through the retorts. In fact, it is claimed that practically every constituent part of the blackboy is turned to good account; even the final ash produced in the retorts is used in the manufacture of a fertilizer of a high potash content. Pyroligneous acid fluid is distilled from blackboy for use as a weed destroyer. This fluid also forms the foundation for the manufacture of acetic acid, acetate of lime, and acetone. In addition to these lines, the company also intends to produce picric acid, formalin, dyes, and perfumes, and to extend its operations in refining blackboy and other gums for use in the manufacture of varnishes and stains."

CHEAPER ARSENIC.

The Queensland Government is determined to reduce the cost of arsenic if that be humanly possible. It has had a plant for treating arsenic erected at the State Arsenic Mine at Jibbenbar. The Minister for Mines, Mr. Jones, recently said the object of the works was, in the first place, to supply arsenic for poisoning prickly pear and making cattle-dip; but there was another direction in which it might be used to advantage and save a lot of money. That was in the destruction of weeds along the railway lines of the State. At the present time a good deal of money was being spent in employing labour to keep down the weeds, and this could be better achieved by running a motor along the lines, with an attachment working on the principle of a street watering van, which could throw a shower of poison on either side of the line and destroy the vegetation. If this were done once in three years it would suffice.

EGG ALBUMEN.

The importation of egg albumen, which is used mainly in the manufacture of confectionery, having been prohibited, the Institute has been asked to supply information regarding processes for its manufacture. There are two main processes—one mechanical, the other chemical.

In the former process the white of eggs is strained through silk gauze lining the lead-lined drums of centrifugal machines. It is allowed to settle for 30 or 40 hours, when the albumen is generally found to be clear. In some cases it is necessary to clarify by a little tannin or acetic acid and turpentine oil, and pressure through a filtering apparatus. The clear albumen is then treated as quickly as possible in a stream of dry air or in vacuo (as in the manufacture of condensed milk) under 50° C. (above this temperature the albumen becomes yellow) for about 4 to 6 hours, when it is obtained as thin, clear, elastic sheets, which dissolve with water to a clear odourless solution.

In the chemical method, whites of eggs are beaten up thoroughly with water, when the albumen and salts pass into solution, and the insoluble membranous matter is strained off. The albumen may be partially separated from the soluble salts by dialysis or by precipitating the liquid with basic lead acetate, decomposing the precipitate by carbonic acid, and removing the last traces of lead by hydrogen sulphide. On cautiously warming the liquid to 60° incipient coagulation occurs, and the first flakes of albumen carry down with them every trace of lead sulphide, leaving the liquid perfectly colourless. On evaporating the solution at a temperature below 40° and completing the desiccation in shallow trays, the albumen is obtained in the form of transparent, pale yellow, horny scales, which may be reduced to a yellowish white powder. In the solid state it may be kept without change, but the solution readily putrefies.

ALCOHOL FROM SUGAR CANE TOPS.

Inquiries have been made as to the practicability of profitably manufacturing alcohol for power purposes from cane tops.

As a matter of fact, the sugar content of cane varies very much, equally in the stems as in the tops. The amount will also depend on where the tops are cut off, whether they are to be left on the field to be ploughed in, or taken to feed stock. If the thrashing has been done some time before cutting, the green cane under the leaves ripens, and the cut is made just *above* the base of the last leaf. The percentage of hydrolizable sugars might be taken as 2.6 per cent. If a little more of the stalk is taken when cutting off the top, *i.e.*, *below* the last leaf, the percentage might rise to 4.6 per cent. or 5.9 per cent. as a maximum. The moisture would be about 70 per cent.

One ton cane tops should produce from 3.63 to 8.24 gallons absolute. Thus from a ton of cane tops we might reckon on an average, say, 4 gallons absolute alcohol, but varying up to, say, 7 gallons, depending on place of cutting off top, ripeness of top, and variety of cane, &c. It is not very safe to generalize too much for calculation, and it is better to be on the conservative side and calculate on a rate of 4 to 5 gallons.

POWER-ALCOHOL IN GREAT BRITAIN.

In a report issued by the British Committee which was appointed to investigate the question of alcohol as a fuel, the opinion is expressed that the time has come for action by the Government to insure close investigation of the questions of the production and utilization of alcohol for power and traction purposes. It is pointed out that there are in the British Empire vast existing and prospective sources of alcohol. The report proceeds:—

> "As the price of alcohol for power and traction purposes . . . . . . must be such as to enable it to compete with petrol, it is essential that all restrictions concerning its manufacture, storage, transport, and distribution should be removed so far as possible consistent with safeguarding the revenue and preventing improper use, and that cheap denaturing should be facilitated. We recommend that an organization should be established by the Government to initiate and supervise experimental and practical developmental work at home and overseas, on the production and utilization of power-alcohol. . . . . This organization should be permanent, have at its disposal the funds necessary for its investigations, and be in close relation with the various Governments of the Empire. . . . ."

The report strongly emphasizes the fact that the power-alcohol industry cannot be left entirely to the chances of private enterprise, individual research, and the ordinary play of economic forces, and urges that serious consideration should be given to the question of State action to educate the public concerning the merits of power-alcohol by demonstrations, lectures, exhibitions, and other appropriate means. It is claimed to be equally essential that the necessity of allowing fermentation and distillation to proceed simultaneously in the same building, and of permitting continuous distillation, should receive early consideration.

The views expressed in the above report appear to be very similar to the conclusions reached by the Special Committee on Alcohol Fuel and Engines which was established by the Institute. This Committee issued a comprehensive report on the whole subject in December, 1917, and, among other things, recommended the Government to grant a bonus on power-alcohol. No action has, however, been taken by the Commonwealth Government to facilitate the production of power-alcohol. On the contrary, an Excise duty of 1s. per gallon has been placed on methylated spirits.

POWER-ALCOHOL IN AUSTRALIA.

At the request of the Motor Traders' Association of South Australia, the Institute arranged for a demonstration to be given in Adelaide on the 26th July last, of the practicability of running motor cars on alcohol, and of starting them from cold on that fuel. Thirteen cars were provided for the purposes of the tests. No difficulty was experienced in starting and running any of these cars, and in no case did it take more than nine minutes to make the necessary adjustments.

In a letter addressed to the Institute, the Motor Traders' Association state that the tests were entirely satisfactory and that they illustrated to a number of motor traders and their mechanics that the Institute's experimental work had reached a successful stage. The results also showed that, in the event of the petrol supply being cut off at any time, cars could be run successfully on alcohol. The Association expressed the opinion that the successful stage to which the experimental work has been brought by the Institute is bound, sooner or later, to prove of great value to the Commonwealth.

The Institute has received requests from the Motor Traders' Associations of New South Wales and Victoria to give similar demonstrations in Sydney and Melbourne. Arrangements are now in hand for this to be done.

INTERNATIONAL RESEARCH COUNCIL.

ACTION IN AUSTRALIA.

As a result of meetings held in London and Paris towards the end of 1918, it was decided to establish an International Research Council representative of Allied and neutral nations to take the place of existing International Committees for work in various branches of science. It was decided that the International Council should be a federation of National Research Councils. The chief function of the International Council will be to establish unions for various branches of science. Two of these have already been established—one for Astronomy, the other for Geophysics—and an International Chemical Council is now in process of formation. The chief functions of the National Councils are to appoint delegates to the special unions and to contribute to the work. Each of the self-governing Dominions is included in the scheme as if it were a separate nation.

In February last an invitation was sent by the Executive Committee of the International Research Council to the Royal Society of New South Wales, asking it to take steps towards the formation of a National Research Council for Australia. The Royal Society of New South Wales accordingly convened a Conference of representatives of the Royal Societies of each State of the Australasian Association for the Advancement of Science and of the Institute of Science and Industry. Professor Masson represented the Institute. The Conference was held in Sydney on the 21st August, and a provisional National Research Council, consisting of 31 members—two members representing each of fifteen main branches of science and an Honorary Secretary—was appointed. An Executive Committee of five members, all resident in Sydney, was also elected.

The following members form the Provisional Australian National Research Council, as representatives of the sciences attached to their names:—

Mathematics	Professor H. S. Carslaw, M.A., D.Sc., Sydney. Professor H. J. Priestly, M.A., Brisbane.
Astronomy	W. E. Cooke, M.A., F.R.A.S., Sydney. J. M. Baldwin, M.A., D.Sc., Melbourne.
Physics.	Professor T R. Lyle, M.A., D.Sc., F.R.S., Melbourne. Professor J. A. Pollock, D.Sc., F.R.S., Sydney.
Chemistry	Professor D. Orme Masson, M.A., D.Sc., F.R.S., Melbourne. Professor N. T. M. Wilsmore, Perth.
Botany	J. H. Maiden, F.R.S., Sydney. Professor T. G. B. Osborn, M.Sc., Adelaide.
Zoology	Professor W. A. Haswell, M.A., D.Sc., F.R.S., Sydney. Professor W. J. Dakin, D.Sc., Perth.
Geology	Professor T. W. E. David, C.M.G., D.S.O., D.Sc., &c., Sydney. Professor E. W. Skeats, D.Sc., F.G.S., Melbourne.
Physiology	Professor W. A. Osborne, D.Sc., M.B., B.Ch., Melbourne. Professor H. G. Chapman, M.D., B.S., Sydney.
Pathology	Professor Sir H. B. Allen, M.D., LL.D., Melbourne. Professor D. A. Welsh, M.A., M.D., F.R.C.P., Sydney.
Engineering	J. A. Gibson, Newcastle. Professor W. H. Warren, M.I.C.E., LL.D., Sydney.
Agriculture	A. E. V. Richardson, M.A., B.Sc., Melbourne. Professor R. D. Watt, M.A., B.Sc., Sydney.
Veterinary Science	Professor J. D. Stewart, B.V.Sc., M.R.C.V.S., Sydney. Professor H. A. Woodruff, M.R.C.V.S., M.R.C.S., Melbourne.
Meteorology	H. A. Hunt, F.R.Met.S., Melbourne. Griffith Taylor, D.Sc., B.E., F.R.G.S., Melbourne.
Anthropology	Professor Sir Baldwin Spencer, M.A., D.Sc., Litt.D., F.R.S., Melbourne. C. Hedley, Sydney.
Geography	Sir Douglas Mawson, B.E., D.Sc., Adelaide. Major E. L. Piesse, B.Sc., LL.B., Tasmania.

Honorary Secretary: R. H. Cambage, L.S., F.L.S., Sydney.

The following members form the Executive Committee:—

Professor David (Chairman).
Professor Pollock.
Professor Chapman.
Mr. Maiden.
Mr. Cambage (Honorary Secretary).

The Council which was appointed was termed "provisional," as it was decided to place the matter eventually in the hands of the Council of the Australasian Association for the Advancement of Science at its next meeting at Hobart in January, 1921, this Association being the only body in Australia representative of the whole Commonwealth and of all branches of science.

As regards finance, it was pointed out at the Conference that the movement was entirely a national matter, and that it should be clearly recognised as such. It was accordingly decided to make an application for a grant to the Prime Minister, and, if necessary, to arrange for a deputation to wait on him at a later date.

EDITORIAL.

It is somewhat remarkable that the first gift of books to the Library of the Institute should have been made from England and not by an Australian. Mr. T. B. Lightfoot, London, has presented a number of volumes to the Institute, including a series of bound numbers of *Nature*.

Another gift to the Institute's Library has been made by the Trustees of the Victorian Public Library, who have presented a large number of duplicate scientific bulletins.

The President of the British Board of Agriculture has appointed a departmental committee to arrange for the testing, adaptation, and improvement of machines likely to prove of value to agriculture, to examine inventions and new devices, and to advise as to the further steps which should be taken to promote the development of agricultural machinery.

Consideration is being given to the practicability of erecting a co-operative distillery in a Victorian potato-growing district, with the view of converting surplus potatoes into power alcohol. The matter is in good hands.

An Imperial Entomological Conference will be held at London at an early date, and the Institute has been asked to select a Commonwealth representative.

The question of the continuation of the subsidy of £500 per annum which the Commonwealth Government contributes to the International Institute of Agriculture at Rome has been referred to the Institute, which has strongly recommended that the grant be continued.

Labour and Research.

RESOLUTIONS OF THE AMERICAN FEDERATION OF LABOUR ON SCIENTIFIC RESEARCH.

WHEREAS, scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries—manufacturing, agriculture, mining, and others must rest; and

Whereas, the productivity of industry is greatly increased by the technical application of the results of scientific research in physics, chemistry, biology, and geology, in engineering and agriculture, and in the related sciences; and the health and well-being, not only of the workers, but of the whole population as well, are dependent upon advances in medicine and sanitation; so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and

Whereas, the increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population can not progress by the usual methods of readjustment, which limit can only be raised by research and the utilization of the results of research in industry; and

Whereas, there are numerous important and pressing problems of administration and regulation now faced by Federal, State, and local governments, the wise solution of which depends upon scientific and technical research; and

Whereas the war has brought home to all the nations engaged in it the overwhelming importance of science and technology to national welfare; whether in war or in peace, and not only is private initiative attempting to organize far-reaching research in these fields on a national scale, but in several countries governmental participation and support of such undertakings are already active; therefore be it

Resolved, by the American Federation of Labour in convention assembled, that a broad programme of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended; and the Secretary of the Federation is instructed to transmit copies of this resolution to the President of the United States, to the President *pro tempore* of the Senate, and to the Speaker of the House of Representatives.

The Conservation of Health.

J. H. L. CUMPSTON, M.D., D.P.H.*

The spirit of scientific inquiry is abroad to-day. The world, startled into realization by the demands of peoples, intent on destroying their neighbours, for weapons of greater and still greater precision, has come to recognise that reliable facts in any field can only be discovered by those patient and laboriously accurate methods collectively known as science.

Scientific investigation has at last attained its place, at least in so far as that paramount human impulse—the destruction of other humans —is concerned.

It can, however, hardly be hoped, that the human people, generally, will, within any reasonable time, become endowed with that characteristic inheritance of the true scientist—the faculty of prevision.

These two great principles, accurate investigation according to accepted scientific rules, and anticipatory provision against imminent ill, form the foundation of preventive medicine, as it should be.

If preventive medicine has not entirely satisfied these conditions, it may, at least, be claimed that considerable progress has been made along these lines, and, moreover, that the structure now being built has been commenced on these foundations.

In any discussion of the application of that branch of science known as Preventive Medicine to Industry, it is necessary to clear away certain popular mistakes, and to define what preventive medicine includes, and what results are possible.

The present general conception of public health is very limited, and is restricted almost entirely to the exercise of "police powers" by the State in regard to matters of environment, *i.e.*, such unclean conditions external to the individual as are presumed to encourage ill-health, and to the control of persons found to be affected with some infectious or contagious disease. It is true that there are certain other matters which are now receiving some attention, *e.g.*, the control of midwives, and the medical inspection of school children; but such important matters as baby clinics have not yet been adopted as definite functions of State.

The modern *Health Department* should be concerned with *all* matters which favorably or adversely affect the health and physical welfare of the people, and should be actively concerned with keeping people well, rather than with keeping their back yards clean, or imprisoning them in quarantine when an infectious disease occurs. Not that it is to be thought that these things are unnecessary. They will always be necessary, but they should take their place as, at the most, equal to, and, better, as secondary in importance to, the well-being of the individual.

Every person's life is mainly spent under two sets of conditions—the place where he earns his livelihood, and the place where he eats, sleeps, and rests.

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* Director of Quarantine.

The individual's health will depend mainly, apart from inherited conditions, upon the nature of his work, and the conditions under which it is performed, and on the conditions under which he lives domestically. The domestic conditions may be rendered hygienically desirable by education, and where that fails, by compulsion.

The present remarks are concerned only with the conditions of daily work.

Any well-conceived scheme of preventive medicine, as applied to industries of any sort, must be directed to the primary objective—that of keeping people in sound health. In order to accomplish this, it is necessary to know what conditions of ill-health exist amongst those who earn their living in any form of industry, what ailments are special to any form of industry, and what preventive measures may be applied to avert the onset of these ailments.

If preventive medicine can be applied in such a way that the cause of any particular form of ill-health can be discovered and removed, then "industrial hygiene" will have ceased to be a mere catchword, and will have begun to be a department of science having a real value to the community. It can easily be shown that in many directions the study of disease has revealed a cause, the removal of which, without economic loss to the employer of labour, has removed a large amount of disease, suffering, and ill-health.

An interesting example of partial success and partial failure in this respect is that of the ill-health produced by the inhalation of aeroplane "dope." In the earliest stages of the war, this "dope" contained a poison which gave rise to a toxic jaundice amongst those engaged in its manipulation and manufacture. In addition, numerous cases of less severe illness occurred. The manufacture of this particular "dope" was discontinued, and the characteristic illness at once ceased. The authorities have, however, not yet succeeded in discovering an entirely harmless "dope," those now in use producing headache, cough, and a serious anæmia. The precautionary measures in force have reduced this sickness to a minimum without entirely abolishing it.

The very satisfactory results which have been attained in past years in preventing fibrosis of the lungs arising from dust irritation, in preventing lead poisoning, mercury poisoning, and phosphorous poisoning in the respective trades in which these risks occurred, are striking examples of the benefits derived from the application of the system of scientific medical research, combined with application of the knowledge so acquired.

It must be realized, however, that, hitherto, efforts to protect the health of industrial workers have been mainly based on the need for investigating or removing admitted evils as they arose, rather than on the actual results of systematic inquiry and research. Increasing attention has certainly been devoted in recent years to the critical examination of certain "dangerous trades," but most trades are not "dangerous," and the vast bulk of industrial disease does not find its origin in the so-called "dangerous trades." Yet there is considerable evidence that rates of sickness and mortality are materially affected by occupation.

Sickness due directly, or indirectly, to industrial occupation takes various forms and degrees, from the passing headache due to eyestrain or impure air, to serious organic disease resulting in death. The lungs, the heart, the digestive organs, the nervous system, the muscular system, each or all may be affected with results harmful both to industrial efficiency and output, and also to personal health and expectation of life. Certain occupational conditions have to be seriously considered in this connexion. Examples are:—

Excessively long hours of work. Fatigue plays an important part in favouring the development or transmission of disease.

Cramped or constrained attitudes or postures during work which prevent the healthy action of the lungs or heart.

Prolonged or excessive muscular strain which may produce rupture, varicose veins, or possibly arterial degenerations.

Machine accidents.

Working in unventilated or insufficiently ventilated premises predisposes to disease, and interferes with individual energy and physical capacity. The effect of continuously working in a polluted atmosphere may be very serious.

Imperfect lighting, whether natural or artificial, especially when combined with the use of material of certain colours, induces eye-strain, headache, or permanent eye defects.

Working with or in the presence of gases, vapours, poisonous or other irritating substances, may lead to direct poisoning.

In the case of women there are special features:—

Disturbances of digestion due to unsuitable food, irregular and hurried meals, or to fatigue.

Anæmia.

Headache and nervous exhaustion.

Muscular pains and weakness.

Derangement of female physiological functions.

It is unnecessary to extend this list further. There is obviously a wide scope for the investigation of the presence of, and the causes of, ill-health in every trade or profession. It is equally important, economically, to the community to determine whether the excessively long hours worked by a doctor in general practice reduce his expectation of life, and dispose to the occurrence of ill-health, as it is to determine the extent of phthisis amongst miners, or of adenoids amongst school children. In all of these things, the critical methods of exact scientific investigation must be applied. There has been too pronounced a tendency to assert that certain results are due to certain causes, without endeavouring to establish the exact facts.

General statements of a loose kind have in the past done much harm, and careful search for facts in relation to the actual prevalence of ill-health, the causes of such, and the appropriate remedies is urgently needed.

It is beyond question that the immediate duty of the Commonwealth at this time is production, and it is a wise policy which endeavours to insure that all the resources of science shall be applied to industry, so that production may be raised to, and maintained at, its highest level.

It is, however, much more important that the human factor shall be carefully studied, that, in producing wealth, the worker shall not lose health. Better a healthy people than a wealthy people, if a choice were necessary. And, as things stand to-day, there is not the study of the nation's health that there might be; there is not the concerted scientific investigation of causes of ill-health and death that there should be; and there is a magnificent opportunity for a broad policy of the preservation of health along modern, well-established lines.

Hepburn Springs Radio-Active.

An Interesting Discovery.

The Hepburn Springs near Daylesford, in Victoria, have been proved to be radio-active. For many years these springs have enjoyed a considerable reputation for their curative qualities, so it seemed not at all unlikely that one day they would be found to possess radio-active powers, like the waters of Bath and Buxton, in England.

Some evidence in this direction was recently obtained by means of radiograph tests carried out by Mr. James Macdonald, the managing director, and Mr. Lees, the works manager, of Hepburn Spa Proprietary Limited. The question has now been settled conclusively by Professor Masson and Mr. G. Ampt, who have proved by a standard electrical method that the gas evolved from the spring, and therefore necessarily the water which carries the gas in solution, is notably radio-active. They intend to carry out a more detailed investigation of the gas, the water, and the dissolved salts, but the results already obtained point without doubt to the presence of niton in the gas and of radium in the sources from which it comes.

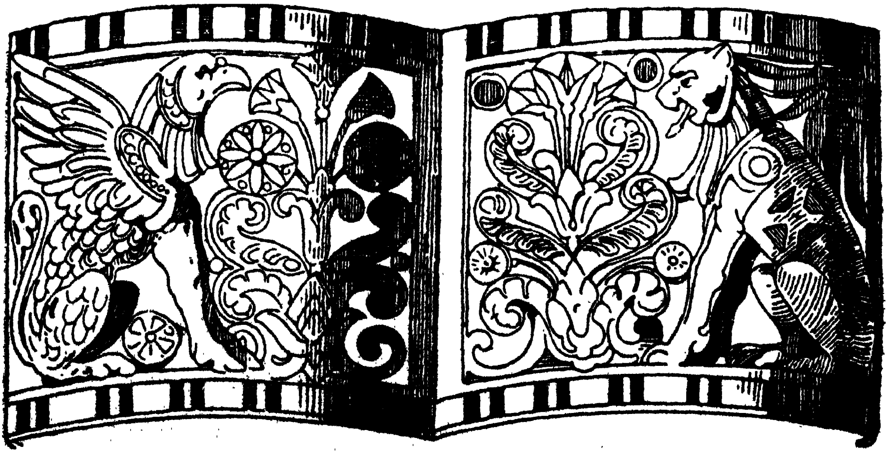
The belief in the curative value of mineral springs is of untold antiquity; yet, till a few years ago, it was impossible to offer a satisfactory explanation of their action. Among equally famous European springs, some are hot and others cold, some contain much dissolved mineral matter and others relatively little. They differ also in the chemical character of the salts which they carry in solution; and, as a rule, there is nothing in their quality or quantity to suggest the possibility of such healing powers as the waters are generally credited with. Moreover, there is evidence that waters prepared artificially to imitate the precise composition of natural springs, as disclosed by chemical analysis, fail to reproduce their curative effects. Were the virtues of the springs, then, purely imaginary? Was it all a matter of faith-healing? Had suffering humanity since earliest times been finding

health in the imbibition of inordinate quantities of aqueous solutions of nothing more potent than self-deception? It seemed hardly probable; yet, if not, the waters must surely contain something of so subtle a character as to escape detection by chemical means.

In the whole history of science, there is no tale more wonderful than that of radio-activity. Less than a quarter of a century ago, absolutely nothing was known of it—the very word did not exist. To-day it is an independent branch of natural science, with a great literature of its own, and with laboratories and skilled researches devoted entirely to its service. Uranium and thorium, among the older elements, were found to possess hitherto unsuspected powers; special means of detecting and measuring these powers were invented; by their aid new and powerfully radio-active elements—radium and others—were discovered, their manifestations studied in detail, and a true theory of their causation built up. And this in turn has thrown new light on the fundamental question of the nature of matter in general.

The physiological effects of radium and its gaseous emanation, known as niton, and their uses as healing agents, are but a side-show from the point of view of the true radio-activist; but to the ordinary mortal and to the medical profession they form the most important chapter of the story. It is a chapter as yet but partly written, and containing sensations and mysteries as yet unsolved.

A few years after the discovery of radium, Lord Blythswood and H. S. Allen proved that the Bath springs, famous since Roman days, and also the well-known waters of Buxton, have radio-active characters which they owe to minute traces of radium and niton. The matter was more fully investigated later by Sir William Ramsay and Irvine Masson; and other experimenters examined other famous springs in Germany and elsewhere, and proved that they also are radio-active. Here, then, is the suspected subtle something, too minute for chemical detection, yet potent enough to affect the electroscope, and apparently also able to influence beneficially that delicate instrument, man.



Poisoning Prickly Pear.

An Interesting Report.

By J. B. HENDERSON, F.I.C., and PROFESSOR B. D. STEELE.

At the invitation of the management of the Cactus Estates Limited, Mr. J. B. Henderson (Chairman of the Queensland State Committee), and Professor B. D. Steele, a member of the same body, were asked by the Executive Committee to visit some of the stations where the company was operating, and forward a report. This was done, and the report is here appended:—

Mr. Henderson interviewed the manager, Mr. J. G. Gregory, at the office of the Cactus Estates Limited, Creek-street, Brisbane. Mr. Gregory stated that the company had abandoned the attempt to clear the 100,000 acres at Dulacca, and no clearing was now being done there, as the cost would be about £7 per acre, and the land was not worth it.

He stated that a contract had just been completed for clearing 12,660 acres of lightly infested country at Noondoo Station, about 120 miles beyond Goondiwindi. The pear had been poisoned and burned off. A copy of a letter from the manager of the Noondoo Station with reference to the work was submitted by Mr. Gregory, and is enclosed herewith.*

Mr. Gregory also stated that a contract was just about to be completed for clearing 100 acres of thickly infested pear country for £700 at Umbercollie Station, near Goondiwindi. It had all been poisoned, and would probably be burned off in about a fortnight. He submitted a copy of the contract, which is enclosed herewith.†

Visit to Umbercollie.

On Wednesday, 25th June, 1919, we left for Goondiwindi, and on Thursday, 26th June, went over the work being done at Umbercollie Station. When we reached the station, the manager, Mr. Heathcote, accompanied us to the paddock, where the Cactus Estates foreman, Mr. Archibald, showed us what had been done.

Pear at Umbercollie.—Mr. Heathcote stated that Umbercollie Station has an area of 50,000 acres, surrounded on three sides by dense pear. Of the station area, 37,600 acres has been kept free from pear, and we were informed that it costs 4d. per acre per annum to keep it clear. There are three paddocks—one of 1,700 acres, one of 10,000 acres, and one of 700 acres—covered with more or less dense pear. It is a 100-acre portion of the 700 acres paddock which is now being cleared for £700.

Reason for Clearing.—Mr. Heathcote also stated that the 100 acres are being cleared to give good access to some permanent water-holes. It is not proposed to clear the other infested areas on the station, as the cost would be much greater than the value of the land.

State of 100-Acre Paddock.—We found the 100 acres block in a much less forward state than we expected. Mr. Archibald stated that there were still about 30 acres to spray, and that it was not expected that the burning-off would be attempted until October next.

* The report shows that the cost of clearing, allowing for wear and tear, is slightly over 7½d. per acre.

† The contract is for 100 acres, and the cost of clearing is £700, or £7 per acre.

Relatively few of the pear plants had been killed outright by the poison so as to show no signs of growth in any part of the plant.

The great bulk of the plants had completely collapsed, but were showing green shoots plentifully from many segments; green shoots were common from the "bulb," and seedlings were springing up among the dried or semi-dried segments.

A considerable number of pear plants were only slightly affected by the poison, the plant still standing with merely the outside skin covered with a yellowish, corky layer. These plants had either not been sprayed or only very lightly sprayed, or the poison had been washed off by rain before it had time to penetrate. In any case, they are very much alive, and the corky layer will largely protect them from further spraying. The presence of those plants will render the task of burning-off a difficult one.

Cost of Clearing. According to the contract, to "kill by poison and clear off by fire the pear" on the 100 acres is to cost £700.

The labourers are being paid £3 10s. per week. There have been from six to ten men employed for over two months in poisoning work. There are still 30 acres to be poisoned, and the work of felling the scrub and burning-off and clearing up odd pear has still to be done. It is obvious that the Cactus Estates Limited is not going to make much profit on this contract.

Conclusion. As the so-called dense pear in this paddock is not nearly so dense as in many other districts, we are convinced that poisoning, as carried out by the Cactus Estates Limited, is much too costly to be considered as an economically possible means of clearing off pear of even medium density.

Statement of the General Problem.

The results of the visit which we have paid to Umbercollie Station confirm in a striking manner the conclusions that we had formerly arrived at as members of the Board of Advice on Prickly Pear Destruction, and we consider that it will not be out of place to recapitulate briefly these conclusions.

In considering the possibility of eradicating prickly pear it is necessary to classify the infested areas into at least three classes, each of which presents its own definite problems.

The first class consists of heavily and moderately infested areas, mostly of poor agricultural but good grazing value. This group consisted a few years ago of areas each centering around a more or less definite area of infestation. These areas are now tending towards coalescence so as to threaten the great bulk of the pastoral lands of the State. They now cover enormous areas.

We are definitely of the opinion that it is impossible to treat this class of country economically by means of poison. This conclusion is based on the information at our disposal, and by the results of about 10,000 plot experiments carried out under the auspices of the Board of Advice on Prickly Pear Destruction in Queensland. We consider that settlement under present conditions is powerless to cope with this class of country, which will be cleared or controlled, if at all, only by the discovery and utilization of natural enemies of the pest.

This method has already been used with conspicuous success by the introduction of the Wild Cochineal Insect, which has practically exterminated a large area of *Monocantha* Pear. Unfortunately, this insect will not attack any other variety of pest pear in Queensland.

Pending the discovery of some enemy or enemies which shall destroy or control the pear, every effort should be made to prevent the further spread of the pest. This should be attempted by the combined use of settlement and poison.

Belts of pear country, surrounding each large area of infestation, should be carefully selected. Each of these belts should comprise land in such a condition of infestation that it can be economically cleared by the use of poison. Settlers should be established on these cleared belts, which will completely enclose the very heavily infested areas. These settlers should be granted a tenure of the most favorable nature with the condition, which should be strictly enforced, that they must not permit the pear to spread on to their selections. Portions of the belts at present occupied by pastoralists should be brought under the same condition.

2. The second class of pear country consists of infested areas of very large extent, containing more or less scattered clumps of pear. These areas are scattered about the country in patches, and they surround the heavily infested areas on all sides, joining up the centres of infestation already referred to, and tending by the increasing density of the pear which they carry to spread the first class over the whole of the infested area.

This class of country, which will be outside the protective belts suggested in the foregoing, can be cleared at a moderate cost by the use of suitable poison applied at the proper season, the dead or seriously injured pear being subsequently destroyed by burning.

It is probable that cost of doing this will in some cases be higher than the value of the cleared land, but notwithstanding this it should be undertaken as a national problem.

3. The third class consists of very lightly infested areas situated on the extreme edge of the other two classes of infestation, and also scattered areas in process of development, where seeds have been carried by birds and cattle.

There is no difficulty at all in clearing such country and in keeping it cleared at a comparatively trivial cost by the use of suitable poison. The task of doing so does, however, call for constant attention on the part of the settler, and the duty of devoting this attention is one that should be emphatically and repeatedly brought to his notice.

It is to be noted in connexion with this problem that roads, reserves of land, and Crown property are in some districts left uncleared where the pear has otherwise been cleared. This infested land remains a source of re-infestation for the whole district. It is essential in connexion with any plan for clearing any district that such roads, reserves, &c., should be cleared and kept clear at the same time as all other infested land in the district. Unless this is done, a quite unnecessary expense is entailed on the surrounding land-holders, and the cost of keeping clear remains a permanently occurring expense instead of being a quickly diminishing quantity.

The problem of attempting to cope with the prickly pear in Australia is one which will severely tax the administrative and material resources of the community, and this fact should be clearly stated and borne in mind by the Governments concerned.

The Task Ahead.

How Science can Assist.	A Wide Field of Endeavour.

Now sit we close about the taper here,
And call in question our necessities.
JULIUS CÆSAR.

By F. M. GELLATLY, LL.D.

NOW that the Institute is seeking statutory recognition, it may not be out of place to survey the field of scientific endeavour that lies before it. This field is continent-wide, embracing every clime from the torrid zone of the Gulf of Carpentaria to the cool tablelands of the Monaro. It covers the dust-swept deserts of the centre of Australia, as well as the fertile and well-watered lands of Tasmania. It does not stop at the surrounding ocean with its wealth of fish, its sponges, its pearls; nor is it confined to the surface of the Commonwealth to the exclusion of what lies underground--rich in metals, in gems, and plastic clays; nor are the secrets of the air beyond the limits of its inquiry, what with its bird and insect life, and its more modern human flyers. It has regard to the infinitely great and the infinitely small. No! There is scarce a phase of human endeavour in which it is not interested, and which, sooner or later, will not come within the scope of its untiring research. The work to be done is great, but the rewards of success are still greater. These rewards will not be the mere sordid ones measured by salaries paid or fees earned, but will be that more solid satisfaction which is the invariable accompaniment of a national duty well done.

Let us, at this juncture, eschew generalities and proceed more to detail. There are some most important problems facing Australia to-day which can only be solved by patient scientific research. Take some trite instances, for the bigger things have been much discussed, though little that is practical has been done. There stands in the forefront the prickly pear menace, one that threatens to drive the inhabitants of Queensland, and the northern portions of New South Wales, into the sea. It has already enveloped 20,000,000 acres, and is estimated to be extending at the rate of 1,000,000 acres a year, or, say 5 per cent. Consider what this means! Those mathematically inclined may exert their ingenuity and tell us precisely how long the prickly pear, at its present rate of progress, will take to infest the whole continent at 5 per cent. increase per annum compounded. Remember the story of the grain of wheat on the chessboard doubled at each square. The Persian potentate had no mind for figures. He did not realize that his consent to rewarding his victorious general by doubling a grain at each square represented more than the whole of the wealth of his Oriental domain. So with prickly pear. If nothing be done to stem its fateful advance, the 20,000,000 acres to-day given over to this pest will, in 14 years be 40,000,000; in 28 years, 80,000,000; in 42 years,

160,000,000; in 56 years, 320,000,000; in 70 years, 640,000,000; in 84 years, 1,280,000000; and in less than a century, 2,560,000,000 acres,

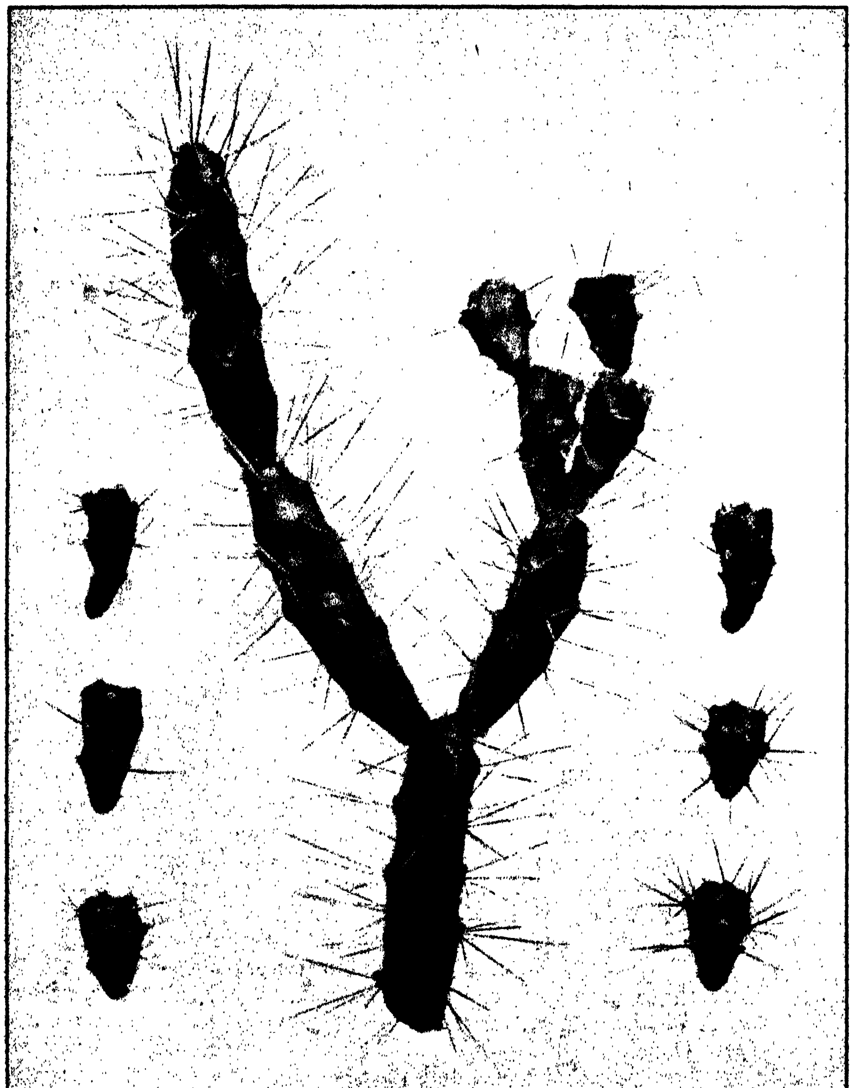


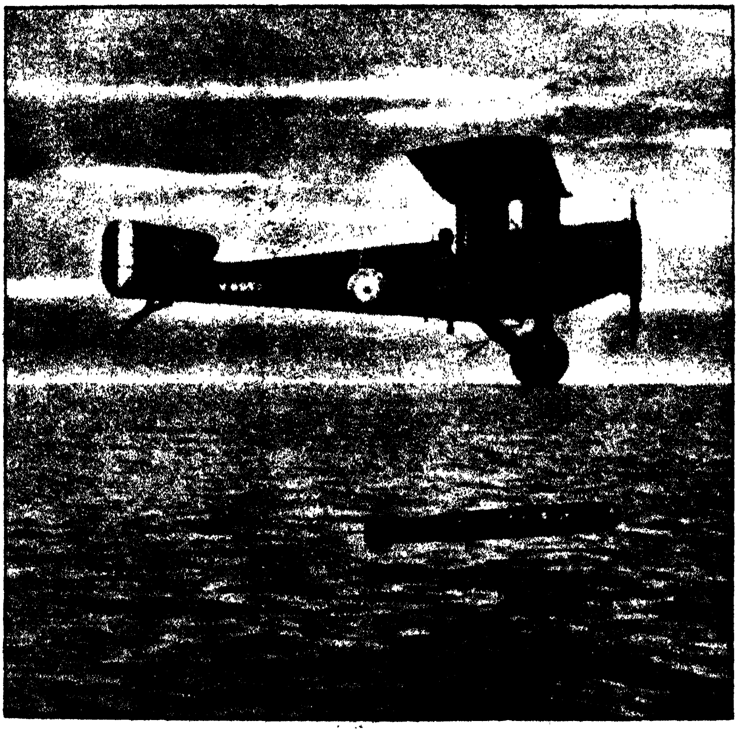
Photo., Dept. Agriculture, Brisbane.

"THERE STANDS IN THE FOREFRONT THE PRICKLY PEAR MENACE."
The notorious "Jointed Cactus" of South Africa, as grown at Roma, in Queensland.

or more than the whole area of the Commonwealth. By that time the annual increase would have reached over 125,000,000 acres. These

figures are not so fanciful as they seem. They convey, even to the unimaginative mind, what prickly pear, spreading at a present rate of 1,000,000 acres a year, may mean. What a task for a brainy entomologist, or biologist, or chemist! The other day, the Minister for Lands in Queensland remarked to the writer that the Government of that State would willingly give any one a free grant of 1,000,000 acres of pear land if only the grantee would guarantee to clear it. What a prize!

Now, take cattle tick. That pest has caused millions sterling of loss to the cattle raisers of this country. It is costing the State Governments of New South Wales and Queensland scores of thousands each year, not to exterminate it, but merely to keep it from making further



"THE SECRETS OF THE AIR."

encroachments. This problem is not peculiar to Australia. The Americans are facing it too. They are driving the tick back slowly but surely, at great expense, with the aid of an army of officials. They dip and quarantine, dip and quarantine, and so on slowly and painfully cleaning it up. There may be an easier and a cheaper way, if only we can find it. Here is a task for a biologist with a brain.

Then again, there is the sheep-fly and the nasal-fly, braxy in sheep, black disease, contagious abortion in cattle, as well as tuberculosis and all the other ills that stock are heir to. These afford ample scope for the entomologist, the microbiologist, and the rest. The denizens of the north and the west build their homes on piles, not, as is the case

with the tree-dwellers of Papua, to keep out of reach of human foes, but to keep their houses free from the depredations of the white ant, the scourge of sub-tropical and tropical lands. The scientist who discovers a way of combating this insect really effectively, and without entailing over much expense, will save hundreds of thousands sterling per annum. Here is a chance for the chemist possibly, or possibly the entomologist, or possibly for a combined effort from both. The borers that eat into the piles upon which our wharfs rest have still to be dealt with at the hands of science.

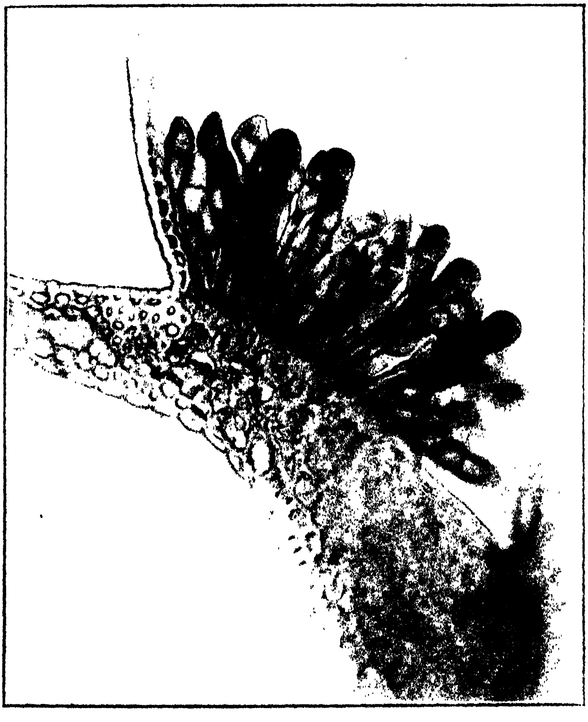
Quite another series of problems have peculiar application to the larger centres of population. The smoke nuisance, the dust trouble, if properly tackled and overcome, will materially reduce the daily labour of countless housewives, and add much to the general health and comfort of the community. Neither of these evils should be insolvable. The disposal of city garbage should be dealt with on more scientific lines, and greater use made of the by-products of its distillation. The waste products of countless factories should be put to fuller and more systematic use. In the past, we have been prodigal of our resources. We can no longer afford that luxury. We burn coal by the million

"ITS WEALTH OF PEARLS." PEARLING FLEET AT THURSDAY ISLAND.

tons each year, and allow 40 per cent. of its value to go up the flue. The dumps from our mines, and the slag from our furnaces, have still unknown riches to yield up. The sands of the sea, the water of the ocean, can, at a price, be made to yield unseen gold; so can the modern alchemist transmute many seemingly worthless things into substantial banking accounts for the enterprising and the skilful.

The scour from the wool-wash is rich in potash; the common seaweed on the beaches contains iodine; the water hyacinth, potash; sawdust from the timber mills, acetic acid, alcohol, and tar; straw can be converted into a valuable illuminant; the essential oils of our bush plants into additions to the pharmacopœia, and so on *ad infinitum*. The resources of the Commonwealth are well nigh inexhaustible, and will yield untold wealth to the scientifically-trained mind.

Or let us consider that important work, the scientific breeding of plants and animals. It has been universally accepted that he who makes two blades of grass grow where one grew before deserves well of mankind. Apply this principle to agriculture, and consider it in reference to the cultivation of wheat. Farrer has proved what may be accomplished by selection of wheat and scientific hybridization. He has added millions sterling to the value of the annual production of Australia. But he confined his efforts to wheat only. What about maize, barley, oats, sugar cane, cotton? What about our native grasses? What about our orchard trees? Let any one who has visited the average orchard recall the poor trees he has seen. A poor variety of, say, orange takes just as much out of the soil as the best does, and requires just as much cultivation. Yet its product may not be worth one-half or even one-fourth

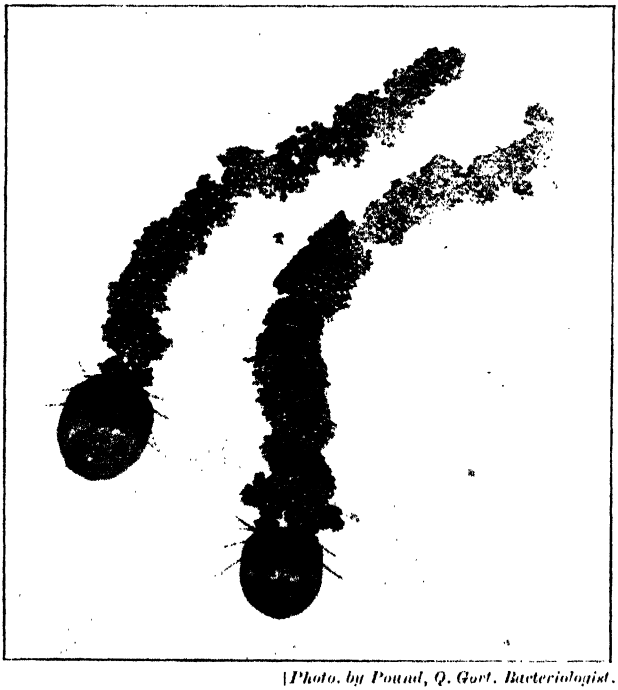


"IT HAS REGARD TO THE INFINITELY SMALL." RUST IN WHEAT GREATLY MAGNIFIED.

as much. So with stock-breeding. Our flocks and herds are susceptible of immense improvement as soon as the benefits are fully recognised. Consider what the sheep-breeders of Australia have already done; how they have added pounds per sheep to their average yield of wool. Wonders still remain to be accomplished right throughout the whole world of live-stock.

There is an entirely different set of problems, the solution of which cannot but bring credit to the Institute and benefit to the country.

Australia, on account of its isolation, gains and loses something compared with other countries. In war she cannot easily be attacked, her boundaries knowing no other frontier than the sea. On the other hand, if she is attacked and her sea-borne commerce is temporarily cut off, she must be self-sufficient in order to be able to continue to fight. Her ships, her motor service, her aircraft, must have an ample supply of liquid fuel. To-day they are dependent upon petrol produced in America or Borneo. It rests with our scientists to discover a substitute—some raw material that will yield up industrial alcohol in an economical way. There are plenty of known raw materials, but most of them are too costly. The low temperature distillation of coal may be the solution of the problem, or it may be that the huge shale deposits of the Wolgan Valley may yet be the salvation of Australia.



[*Photo. by Pound, Q. Govt. Bacteriologist.*

TICKS LAYING EGGS BY THE THOUSAND.

"This pest has caused millions sterling of loss to the cattle raisers of this country."

Industrial efficiency in a nation is largely dependent upon three or four cardinal factors—(1) well-trained workmen; (2) cheap fuel; (3) cheap and effective transport, and (4) organization. Take these factors in order and consider what part the scientist can play in each. First there is the efficiency of the workman. This is contingent upon effective technical training; upon his health, which rests upon comfortable housing and scientific sanitation; upon his contentment, which depends upon his general surroundings, and upon his feeling that it is not a hopeless task for him to provide for a comfortable old age for himself, and opportunities for his offspring equal to those of the most

influential in the land. Secondly, cheap fuel goes to the root of all secondary, and some primary, industries. This must be had at any cost. Thirdly, cheap and effective transport includes not only railroad and steam-ship carriage, but that no less important factor, transport by road. Scientific road-making and maintenance is one of the most important *desiderata* in Australia to-day. Most of our roads are execrable, which throws a heavy and perpetual burden upon all industry. If the Institute could introduce up-to-date methods of road-making into the Commonwealth, and do no more, it would more than justify its existence. Then there is the remaining factor of organization. This is many sided. It connotes such matters as the proper selection of factory areas so as to secure efficiency in handling and convenience to the workers. Take the position to-day in Melbourne, Australia's first manufacturing capital. Here the factories are mixed up in residential areas, often far removed from the railway and wharfage accommodation; often, also, far from the homes of the workers. This kind of Topsy-like growth spells costly production, and inability to compete on equal terms with more efficient rivals. Then there is quite another phase of organization, that inextricably connected with the word standardisation. Are manufacturers to be asked to consider every fad, every prejudice, of a hundred and one consumers, or is there to be some limit, and consequently some possibility of economy, in production? Then, again, are dozens of manufacturers going to continue to produce according to scores of patterns, or are some to have a virtual monopoly of some lines and others of other lines, thus still further aiding economy of production and ability to compete? Standardisation is a weapon of great fineness. It can win where the cruder weapon of the protective Tariff fails. Without standardisation as a condition precedent no Tariff wall could have been built high enough to have made it possible for Australian manufacturers to roll tramway rails in Australia with our present population, and consequently limited demand. There is another side to standardisation. How long is the Commonwealth going to be content to be the dumping-ground of the rejected goods of the world? Watches that will not keep time; thermometers that cannot once, except by accident, accurately measure the temperature; matches that will not strike; boots that will not wear; and a thousand and one things that are mere frauds may come into the Commonwealth to-day with impunity. One day science will fix standards of quality as well as standards of size and weight. It is a shame that our producers and our manufacturers are compelled to compete against such obvious deceptions, and that our consumers are not protected against such transparent fraud. Science must and can help. This will come within the province of the Bureau of Standards.

It would be impossible, even were it desirable, to cover the whole field that lies before the scientific workers of the Commonwealth. Their labours affect every home, every occupation, every aspiration. They go to the very root of our material progress, of our national well-being, and of our racial security. Who ever had a greater task!

The Grape in Australia.

An Aid to Closer Settlement. □ **Industry that Wants Encouraging.**

"I often wonder what the vintners buy
One half so precious as the goods they sell."
OMAR.

By JOHN DUCE.

THERE is, perhaps, no industry for which Australia is so peculiarly suited as the wine-making industry, for whereas in Europe, owing to their moist and uncertain summers, they can only produce a "vintage wine" about once in five years, our dry, rainless summers enable us to produce a perfect wine every year. Australia should be, not only the "Empire's Vineyard," but it should produce the export wines for the whole of the world.

No industry is so conducive to close settlement as the "Wine Industry." At a very conservative estimate every 8 or 10 acres of wine-grapes should provide in vineyard, cellar, cooperage, transport, &c., full employment for one adult—in other words, should maintain one family. The annual value of all our Australian agricultural, pastoral, dairying, poultry, bee-farming, forestry, fisheries, mining, and manufacturing industries, amounted in pre-war times to only £195,000,000, and we are told that only by increased production can we hope to meet the costs of the late war. Then why do we not take seriously in hand the wine industry. We are at present producing the comparatively insignificant quantity of about 6,000,000 gallons per year, worth probably about £1,000,000. Compare this with the—

French vintage of	..	..	1,300,000,000 gallons,
Italian vintage of	..	..	947,000,000 gallons,
Spanish vintage of	..	..	520,000,000 gallons,

and consider that the French vintage alone, at an average price of 2s. per gallon, represents an annual value of £130,000,000—just about two-thirds the value of *everything* that is produced in Australia. It is also estimated that about 25 per cent. of the French population live either directly or indirectly upon the wine industry, and where can one find a braver, healthier, more prosperous, more contented, or more sober people than the French?

Centuries of experience and keen competition have taught European vignerons that certain classes of vines produced their best results in certain districts, and it has consequently been many generations since any attempt has been made in any one of those districts to make more than the one variety of export wines for which it has proved itself to be especially suited, and we find, upon reference to the map of Europe, that the Sherry district is situated about 36° N. lat., the Port district about 41°, the Burgundy district about 45°, the Claret district about

47°, and the Hock district about 50°. These 14 degrees of N. latitude, although tempered to some extent by altitude and proximity to the coast, embrace considerable differences of climatic conditions, differences which experience has proved to be necessary in Europe to the production of the different varieties of wine. A similar range of climatic conditions can be found in Australia, but the absence of any large businesses to undertake the purchase and distribution of Australian wines has compelled Australian vignerons to be their own wine merchants, and to attempt to make almost every variety of wine in the same vineyards—the larger and older-established makers merely erring, in this respect, upon a more colossal scale than the smaller makers; and it speaks volumes for the suitability of our climatic conditions that the average result is anything like so satisfactory as it is. It is almost certain that in none of the European wine countries would similar practices be attended with even approximate results.

The writer well remembers an attempt by the eminent firm of winemakers, Messrs. G. G. Sandeman, Sons and Company, of Oporto, Xerez, and Bordeaux, in the early seventies, to establish a claret vineyard in the Tarragona district of Spain, and a hock vineyard in the Xerez district of Spain, with exactly similar results in each case. The warmer conditions under which the vines were grown than those under which they produced their typical results, caused the grapes to produce more sugar, and this excess of sugar appeared to be produced at the expense of all the finer properties of the grape; for, whilst the resulting wines were free from the thinness and acidity of a cheap French claret in the one case and a cheap German hock in the other case, they never developed any character, and there was a headache in every bottle. The claret was sold as "Valpierre," and the hock as "Bucellas," both at very low prices, but they were withdrawn from the market after two or three years' unsuccessful attempts to popularize them. It is probable that these failures are worth taking into consideration in planting vineyards in Australia for export wines. When the writer left the Old Country, about 23 years ago, Australian burgundies, in spite of extensive advertising, were very far from popular, and those who used them were frequently chaffed by their friends for drinking them on patriotic grounds, and not because of a real preference for them. A wine that is too heavy for a claret, or too light for a port, does not necessarily become a burgundy. We can produce in Australia every type of wine that can be produced in Europe, and we can produce each type of an infinitely higher average quality; but the European experience that results in growing each different type under different climatic conditions is entitled to our very respectful consideration. The wine trade in England would much more readily undertake the distribution of types of wine to which the consumers were accustomed, even if their distribution was hampered by a compulsory alteration in their nomenclature. Some such alteration will probably be enforced as a question of international policy, although nothing is, perhaps, more certain than that the different types are due to varieties of grape and climatic conditions, rather than to soil or territorial conditions. There is a concession in the duty in favour of Colonial wines entering Great Britain of 6d. per gallon upon wines under 26°; and of 1s. per gallon upon wines over 26° and under 42°. This concession might well be made more liberal,

having regard to the extra cost of freight, casks, &c.; but the better average qualities of Australian than of European wines should render any preferential treatment at all quite unnecessary. In addition to the English market, there is a demand in some of the Eastern markets for about 40,000,000 gallons of wine per annum. This has, hitherto, been principally supplied from Europe, but Australian wines have been successfully introduced into these markets, and if our stocks were equal to it, doubtless the whole of this trade might be captured by Australia. Even the local demand is almost in excess of present supplies. All makers appear to be short of stocks, and to have more business offering than they can accept. A certain amount of development of the industry is assured to enable the increased and increasing local demand to be met, but this will be a mere parochial movement. If an adequate national attempt is to be made to put the industry in a position to compete for all the trade that it could capture, a Federal guarantee may be necessary that no interference by prohibition shall take place without ample compensation. This would probably give such an impetus to the industry that the only difficulty would probably be that of securing sufficient suitable labour; that difficulty would, however, speedily right itself, and at no distant date the wine industry should, and probably would, be the most important single industry in Australia.

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavouring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find by ones experienced in the direction of research. All research professors know that the finding of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

—*RAYMOND F. BACON.*

"The Administrator of Industrial Research Laboratories."

The Microscope.

The Handmaid of Research.

By EWEN MACKINNON, B.A., B.Sc.

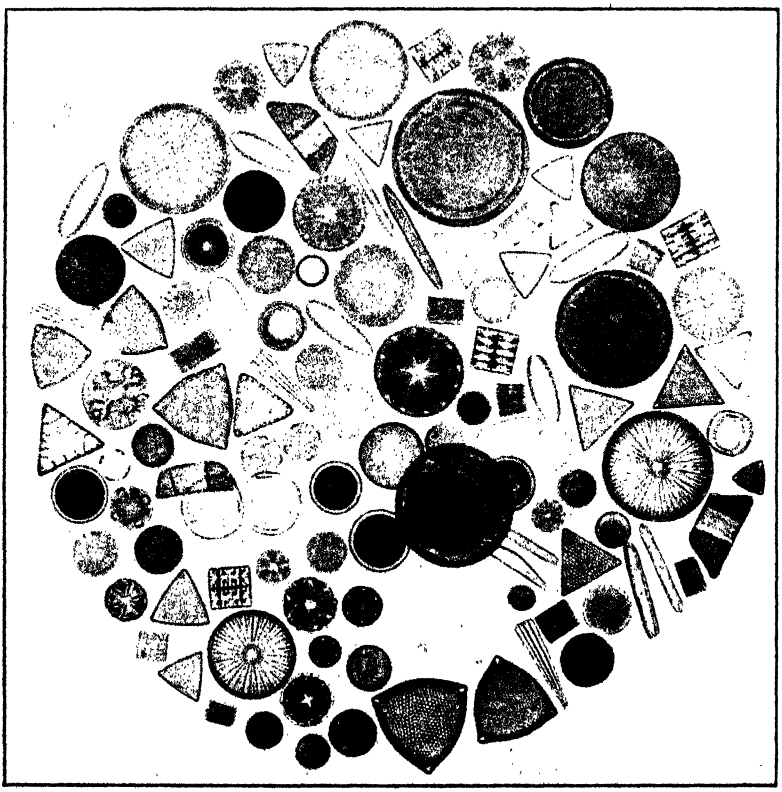
To the lay mind, unacquainted with the microscope and its revelations, the beautiful objects seen through it are ever a source of wonder and delight.

If shown a slide consisting of a thin transparent slice of rock, or a group of some 40 or 50 diatoms symmetrically arranged, or a section of a leaf or stem stained in two colours, say, purple and pink, or a slide containing many hundreds of tiny bacteria, also stained, they soon grow very much interested, and begin to ply many questions, such as, "How are these tiny things put on the slide?" and "How do you colour them?" I well remember a popular lecturer on Nature Study keeping a set of slides which he called his "Oh my!" set. They were sections of various parts of plants, such as the stem, root, leaf, flower, seed, &c., brilliantly stained in two colours, and showing designs like lovely lace, or d'oyleys, or stencil work; and when seen for the first time usually called forth the above exclamation. Hence the name of his set. If their curiosity is further whetted with a slide showing the hairy leg of a fly, spider, or tick, with the various terminal arrangements, either pads or hooks; then with one of the wonderful breathing apparatus of insects, especially well developed in the tongue of a blowfly; followed by a slide of the human flea and the dog flea (both plague carriers) each of which has a pair of eyes; then a blind flea which has a dense collar on the back of its neck like a lady's curved hair comb; they are usually ready to listen to some explanation of their many questions, viz., "How was the microscope found out?" "What are the various parts?" "What is their use?" and finally end up with, "What next will be discovered with it?" I will, therefore, endeavour to give an answer to these questions, and show at a future time what claims the microscope has to the title "Handmaid of Research."

To answer the questions of, What is the microscope, and what are its various parts and their special uses? I shall take you away from the present wonderful achievement of the most up-to-date instrument and go back hundreds of years to the middle ages.

You probably know the story of the discovery of glass. From this early glass the first spectacles were made in 1285 by a Florentine named Amati, who kept the secret for profit, and it was only brought to light after his death. Roger Bacon, in his work *Opus Majus*, states that Clement IV. could show him many marvellous things, and amongst others the crystal lens. However, other spectacle makers flourished in the succeeding three or four centuries, and greatly improved their wares. These spectacles were used to assist ordinary sight, and were bi-convex glass lenses. It was this type of lens that was known in ancient times as the microscope. We now call it a simple lens or hand lens, a magnifying glass—well exemplified in a reading glass, a pocket magnifier, and many lens in eyeglasses and spectacles. Following on the invention of the simple microscope came the discovery of the telescope by that great man Galileo, who not only made his own telescope, but made many fine observations with it.

The early lenses were not of very great magnifying power, and Leeuwenhoek (1632-1723) appears to be the first to succeed in grinding and polishing lenses of such short focus and perfect figure as to render the simple microscope he made much better than any other instrument then known. These lenses he mounted between two plates, and to the plates he fastened a needle, with the object to be examined at the point of it, and in the focus of the lens. In the case of liquid, he placed a drop on a fine little plate of talc. Each instrument was complete with its own lens and object, and he bequeathed many of them to the Royal



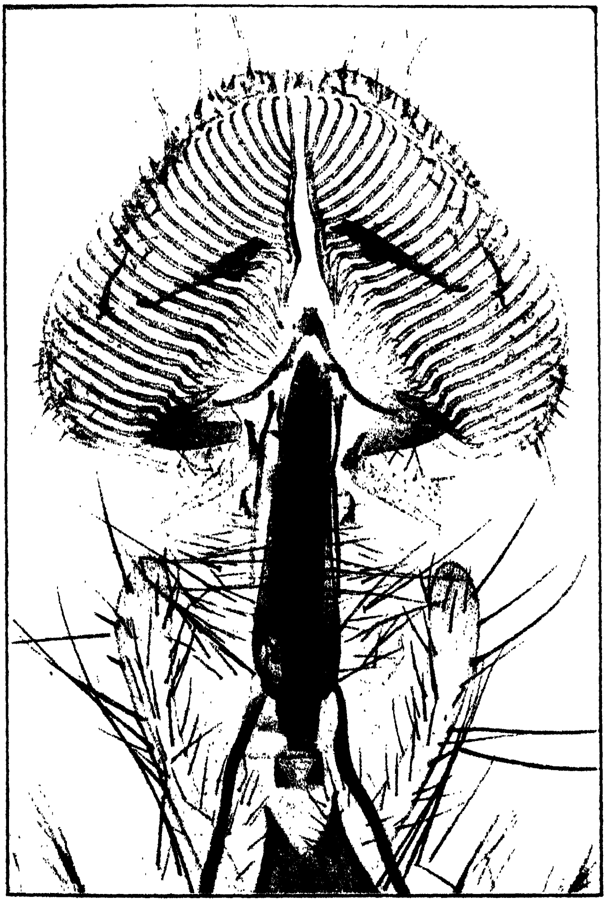
MIXED DIATOMS. THE SKELETONS OF TINY ANIMALS, MILLIONS BEING FOUND IN DIATOMACEOUS EARTH.
Seventy Times Natural Size.

Society, London. He must have been gifted with rare powers of observation, for with these simple magnifying glasses he discovered the active principle (theine or caffeine) of tea and coffee, and described the cellular structure of the coffee berry, and mentioned the oil drops. In vinegar he noticed that there were often minute "eels," which he described and figured. Thus Leeuwenhoek may be given the honour of having made the first microscope examination of food substances.

Two other great workers at that time were (1) Dr. Hy. Power, who published some microscopic observations on sand, sugar, salt, vinegar eels,

mites in oatmeal, &c.; (2) Dr. Robert Hooke, who shaped the smallest of his lenses from small glass globules made by fusing the ends of threads of spun glass. He published his Micrographia Illustrata in 1625, in the *Philosophical Transactions*, describing his invention of magnifying glasses of immense power.

Such simple lenses as Leeuwenhoek and Hooke made are now exemplified by the pocket lens or hand magnifier, and the magnifying or reading glass. They produce an enlarged erect image of an object

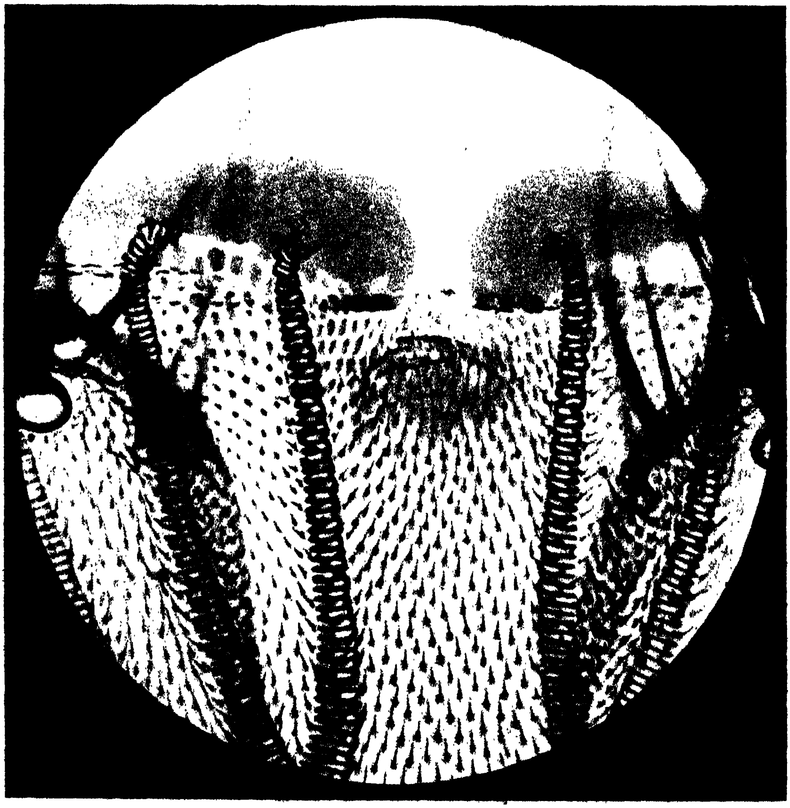


PROBOSCIS OF BLOWFLY. SHOWING SPIRACLES FOR AIR SUPPLY.
Fifty Times Natural Size.

that is placed between the principal focus and the lens, appearing further removed from the lens than the object itself. These lenses, when used as burning glasses, focus the rays of the sun to a central point called the principal focus, and in such simple lenses the length from the optical centre to the focus can be readily measured. (The optical centre in this case is midway between the two curved faces. When the lens is very thick, or where several lenses are combined together,

it is not possible to measure this focal length with any degree of accuracy except in the optical workshop by optical means.) The rays of light from the object, on passing through the lens, are refracted or changed in direction, and meet at the focus of the lens; beyond which they diverge again where they meet the eye. The image is seen in the direction from which the rays entering the eye appear to converge.

This is true with one kind of glass for rays of the same colour only. As light consists of rays of many different wave lengths, a ray of white light is not only refracted, but each wave length is refracted to a different extent, the short waves (*e.g.*, blue) will cross the axis nearer to the lens than the longer wave lengths (*e.g.*, red), and there will



PORTION OF PROBOSCIS OF BLOWFLY. (See topmost portion of block on other page.)
Still further magnified—about 620 times. Shows spiral thickening of breathing tubes, and the minute hairs that cover the whole surface.

result a superposition of coloured images, none of which are perfectly distinct. This defect, namely, that light of different colours is refracted to different extents, is called chromatic aberration. The amount to which the colours are separated is known as the Dispersion. The power of dispersion varies in different kinds of glass according to their composition, and it does not follow that the dispersion produced by two kinds will be in the same ratio as the refraction caused by them. Two glasses

can be selected, *e.g.,* which may have the same refraction, but different dispersion, and *vice versâ.* It is just this property that makes it possible to combine two or more lenses together to counteract this defect, which is characteristic of all simple lenses. We shall refer to this again, but let us discuss another inherent defect of the simple lens. This is known as *spherical aberration*, and is due to the use of spherical surfaces for lenses, as these are the only ones that can be ground accurately. It may be described as the inability of a lens to convey the rays passing through the margins to a focus at the same distance from the lens as the central rays. A ray passing direct through the centre is brought to a focus at a greater distance than a parallel ray passing through near the edge. Hence, if the sun is focussed on a screen by a single lens, there is no single bright point of light produced as an image, but a series of discs of light. This can always be reduced in a single lens by using a "stop" which cuts out the more marginal rays. One can readily prove this by cutting a circle of thick brown paper to fit just inside the rim of a reading glass, and then cutting a central hole in the paper, amounting to, say, half or less than the whole diameter, and observing some print through the glass, with and without the stop. By keeping the eye and the print fixed, and alternately using the centre of the glass, through the aperture in the paper, and then covering the centre over with the piece cut out and looking through the edges only, this difference in focus will be readily seen by having to move the lens to bring the print into focus through the margin.

Now, a bi-convex lens will focus light to a focal point, and so also will a lens known as a plano-convex, *i.e.*, convex one side and flat on the other. Lenses are also made bi-concave, *i.e.*, concave both sides, consequently thinnest at the centre and thickest through the edges. These lenses, instead of bringing parallel rays of light to a focus, will make the rays diverge. A similar result is obtained by a plano-concave lens. It is now possible to combine different kinds of glasses, and different shaped lenses, in such numerous ways as to counteract the chromatic and spherical aberrations to a very large extent.

It was only about 150 years ago that anything except crown glass was available to the lens maker. Optical glass is only about that number of years old. A new type was introduced in flint glass, having a greater refraction and still greater dispersion than the old crown glass. It was made from light to heavy, and in the majority of lenses to-day these crown and flint glasses are to be found.

It is now a common practice to make compound lenses of a convex lens of crown glass (+ lens) and a concave lens of flint glass (— lens), which are achromatic, on account of the large correction of the chromatic aberration.

Two colours are made to come to the same focal point. These are usually, for ordinary visual work, a part of the red orange spectrum, and a part of the greenish-blue region. For photographic work it is the yellow and blue rays.

As long ago as 1762, Euler began a discussion on the theory of the achromatic microscope. In 1811 Fraunhofer made achromatic doublets, and by 1823 there were microscopes with high powers of four doublets screwed together, and capable of magnifying up to 1,200 times.

Further improvements were brought about by a combination of forces in Germany. New substances were used in glass-making at Schott's glassworks; and, from calculations by E. Abbe, the firm of Zeiss produced the apochromatic objective in 1886, the most perfect type of objective yet made from the new Jena optical glass, in conjunction with minerals of special optical qualities like fluorite.

In these the correction is so made that three colours are combined in the one focus, and spherical aberration is removed for two colours. Some of these apochromatics have as many as twelve lenses, and are consequently very expensive. The orange and green may be combined, and the combined result made to agree with the violet.

Even in these objectives there is a slight difference in the size of the red and blue images—the red being smaller. This is controlled by a special eye-piece to go with them, in which the red image is magnified more than the blue, and so compensation effected.

The objective is the most essential part of the microscope, and is used to produce a real magnified image. The difference from the simple microscope is due to the difference in situation of the object looked at and the focus. In the simple lens, the object is nearer the lens than the focus. If it is put further away than the focal length, we shall also get an inverted image. In the objective, the focus of the whole is greater than that of the front system, hence the object is at a distance from the front system greater than its focal length (*i.e.*, at the focus of the whole system), and hence a real inverted image. By the use of an eye-piece of simple construction the diverging rays from the objective forming the image must be collected together so that they may enter the eye. Hence the commonest type of eye-piece, known as the Huygenian consists of two plano-convex lenses mounted together, their flat faces uppermost, the lower one acting like a simple reading glass, and collecting the diverging rays from the object image by being placed a little nearer the objective than the plane in which the image is formed. and the eye lens being used to observe and magnify the image. This permits results which are impossible with the simple microscope. The real image can be photographed, can be measured, and can be physically altered by polarization, by spectrum analysis of the light employed by absorbing layers, &c.

The two systems of lenses—objective and eye-piece—are mounted at the ends of telescopic tubes (= the body), which should be capable of alteration by rack and pinion work. The body is fastened by a limb to the head of a pillar, resting on a solid foot, either a horseshoe mass or a tripod stand. At the junction of the pillar and limb, at right angles, is fastened the stage, usually fitted below with what are sub-stage fittings to hold a third optical part known as the condenser; and below that a mirror, plain one side and concave the other, used for reflecting the light to the condenser, which focusses it on the object to be examined, if that is to be done by the use of transmitted light.

Taking the normal visual distance as 10 inches, a lens that has a focal length of 1 inch will increase the angle of vision 10 times, and we say that the lens magnifies 10 times or 10 diameters (written for short, $\times$ 10). Similarly a lens with a focal length of $\frac{1}{6}''$ = $\times$ 60, and a

1-12″ = × 120. This is called the initial magnification in microscope objectives. The eye-pieces are magnifying glasses, and magnify the enlarged image formed by the objective. Eye-pieces generally magnify from 2 to 12 times. Though higher than this are made, they are not recommended, except the type known as compensating oculars. The amount of magnification used in most work does not exceed 1,500 times, such as can be obtained by a 1-12″ or 1-16″ focus objective, called an oil-immersion objective (because the end of the lens dips into cedarwood oil, which fills up the space between the lens and the object under observation), with a × 10 or × 12 eye-piece. Higher magnification with more detail may be obtained by using the best corrected objectives (apochromatic) with compensating oculars. The eye, however, limits the amount of detail that can be observed, and very high magnifications do not increase the amount of detail, but makes it larger only. The magnifications given are only approximate, however, as different makers select different visual distances, and consequently different tube lengths for their microscopes. These vary from 160 mm. (8 inches) to 250 mm. (10 inches), and when using any particular make, the length of tube extension should provide for the exact tube length recommended by the maker, or his lenses will not give their best results.

The unit of measurement in microscopy is the micron, represented by the Greek letter Mu — μ. This is equal to .001 of a millimetre, or 1,000 μ = 1 mm. Since a mm. = 1-25 part of an inch, a micron = 1-25,000 of an inch. The smallest bacteria that are visible with the ordinary method of examination are about .12 μ or $\frac{1}{8}$ of a micron in size (*e.g.*, the Influenza bacillus), *i.e.*, about 1-200,000 of an inch long. Objects smaller than this have to be examined by special apparatus and special methods of illumination. Most microscopic work, however, except bacteriology and kindred work on other parasites, is performed with magnifications not greater than 600 times an amount obtainable with objectives not greater than $\frac{1}{6}$″ focus, and using an eye-piece magnifying not more than 10 times.

There are many reasons why agricultural research should form a prominent feature of the activities of the Commonwealth of Australia. Its ultimate aim is to increase the productivity of the country, and it would be impossible to exaggerate the importance of that at the present juncture; for, when the war clouds have passed away, when men have beaten their tanks into tractors and their bayonets into binder-blades (to modernise a scriptural quotation), and peace once more comes to this troubled world, there will be a huge bill to pay, and that bill can only be paid as the result of increased—and greatly increased—production.

—***Professor R. D. WATT.***

Wheat, Weevils and Bulk-Handling.

By PROFESSOR W. A. HASWELL.

SINCE the Federal and State Governments have decided on the adoption of the method of bulk-handling in relation to wheat, the problem of dealing with destructive insects in the stored grain has assumed a new aspect.

In the period 1916 to 1919, the problem which had to be dealt with was how best to combat the attacks of weevils on the vast stocks of bagged wheat destined, owing to war conditions, to remain stored in this country for a long period until sufficient shipping could be provided to relieve the congestion.

When the conditions prevailing in the wheat stacks and storage sheds were examined, and the published results of various investigators of the wheat weevils and their life-history were studied, it became evident that, in order to get at the root of the evil, what had chiefly to be aimed at was the protection of the wheat from the access of moisture from any source during transit and storage.

Weevils are incapable of attacking wheat of a certain standard of dryness.[1] The hardness which is involved in the presence of a scanty percentage of moisture in the substance of the grain, baffles the mature female weevil in its endeavour to pierce it in order to provide lodgment and food for its eggs and larvæ; and no active multiplication of the pest can take place under such conditions. The percentage of moisture in the grain necessary for the rapid increase of the weevils is a relatively high one—about 10 per cent. of water is necessary. Freshly harvested wheat rarely contains nearly as much moisture as this, and before the conditions necessary for the active multiplication of weevils in it can be established, the additional water must reach it in some way at some stage during its transport or storage. This may be brought about by the carriage in open waggons or railway trucks without tarpaulins during rainy weather; or the wetting may result from defects in the method of storage. To the latter set of causes was due a large part of the damage done by insect agency to the New South Wales wheat of 1915-16, stored at Darling Harbour and White Bay; and that of 1916-17 stored later at Enfield. The stacks were roofed over with sheets of galvanized iron, supported on battens which rested directly on the built-up stack of wheat bags. In consequence of the direct dependence of the roof on the stack, when any subsidence of the latter occurred owing to the depredations of mice, or any other agency, the roof collapsed to a greater or less extent, and in the event of rain falling, the wheat might get a thorough wetting. Moreover, the slope of the roof was often insufficient, and the overlap of the galvanized-iron sheets inadequate; while the hessian walls in close proximity to the sides of the stack, did not provide sufficient protection against heavy rains accompanied by high winds.

(1) This applies to the grain weevils proper (*Calandra granaria* and *C. oryzæ*), which in Australia are by far the most destructive insects occurring in stored grain. The grain-borer (*Rhizopertha dominica*) flourishes in dry grain.

Even, however, if protection from rain—and from ground damp—were thoroughly insured, it would not necessarily follow that inroads of weevils would not take place. There is evidence to show—though the subject has not yet been satisfactorily worked out—that at least during certain stages in the maturing[1] of the wheat grain, or during the dormant[1] condition which follows when the grain becomes ready for the first phase of active growth known as germination, it becomes hygroscopic, and in a moist climate will absorb from the atmosphere water enough to render it fit for the needs of the multiplying weevil.

All of the preceding relating to storage and transport is now, it is to be hoped, a matter of past history. Until the construction of silos, grain-elevators, and bulk railway waggons have reached a more advanced stage, the present system of handling the wheat must be continued. But, following the advice given by Professor Maxwell Lefroy, the Wheat Board of New South Wales now constructs its stacks on an improved plan. The roof is independently supported, and does not rest on the bags of wheat. There is a free space between the hessian walls and the sides of the stack; the floor is laid on ground specially prepared with a view to its being weevil-proof, and is finished with boards covered with hessian to prevent grain spilt from torn sacks or from holes made by "triers" from trickling down into the spaces below and affording facilities for the development of weevil colonies. In addition, the policy of storing the wheat in the warm moist coastal zone is now abandoned.

Soon, however, bulk-handling will come into operation in this State, and probably before long in the two other States—Victoria and South Australia—which produce an exportable surplus sufficiently large to justify the heavy initial expenditure. With this change the problem of weevil prevention and weevil extermination may be very greatly simplified. The risk of widespread invasion by weevils ought certainly to be lessened, since in the silos and the special trucks the wheat will presumably be completely protected from rain. There remains, however, always the danger of its being wetted before it reaches the collecting silos, and there is the possibly greater danger of the absorption of moisture from the humid atmosphere of the port of shipment, since it may remain there awaiting despatch for a number of months. Once moist enough and with a few weevils introduced, as must happen often even when every precaution is taken in the cleaning processes that precede storage, the mass of grain would offer during the greater part of the year ideal conditions for the development of a plentiful crop of the destructive insects.

But, fortunately, the system of bulk-handling affords special facilities for dealing with such an invasion if it should take place. And by the periodical inspections which would have to be instituted of the condition of the wheat in the silos, such an invasion would readily be

(1) The terms "maturation" and "dormancy" are here used in a very restricted sense. In general biology by maturation is meant the series of changes in the egg-cell (ovum or oosphere) which are preparatory to fertilization. By plant-physiologists the same term is used for the changes which take place *in the ovule after fertilization*, changes leading to the ripening of the seed. By millers and maltsters the term maturation, or maturing, is applied to changes which take place in the grain after it has been harvested. The term "dormancy" is of wide application in biology, indicating any prolonged period of rest or suspension of activity on the part of an organism. Here it applies to grain after it has become "mature" and is completely prepared for germination.

detected at an early stage. When it proved to be necessary the recleaning of the wheat by means of the cleaning plants which will have to be provided in connexion with the silo system in view of the stripping method of harvesting in vogue throughout Australia would be a comparatively simple operation—simple, that is to say, in comparison with the task of dealing with the same condition in bagged wheat.

Should it happen that the infestation by weevils of the wheat in a silo reached an advanced stage before being detected more radical measures might have to be adopted. By the cleaning process the majority of the adult weevils are got rid of; but the eggs and larvæ enclosed within the grains are not affected, and under favourable conditions soon give rise to a fresh crop of weevils much more numerous than that which has been removed. Such a more radical and at the same time relatively simple method of dealing under the bulk-handling system with weevily grain seems to be indicated by the following:-

For centuries a method of bulk storage of grain (rice, and, in more modern times, wheat) has been in vogue among the natives of various parts of India. Details would be out of place here; it will be sufficient for the present purpose to state that the grain was stored in pits or structures of dried mud and covered with closely packed earth in such a way that it was completely shut off from the air. In such air-tight receptacles no weevil is developed. A similar method, with similar results, is still followed in Malta.

Professor Arthur Dendy, F.R.S., at one time assistant to Professor Sir Baldwin Spencer in Melbourne, and later Professor of Biology in Canterbury College, Christchurch, New Zealand, and now Professor of Zoology at King's College, London, has been conducting a series of experiments (under the auspices of the Grain Pests Committee of the Royal Society), which have an important bearing on this air-tight method of storing grain. He finds that by keeping weevily wheat in air-tight glass receptacles, even under conditions of temperature and moisture most favorable to the insects, the death not only of the adult weevils, but of their larvæ in all stages, results in a few weeks. Wheat in the dormant condition gives off carbonic acid at a slow rate as a result of a process commonly termed respiration. Live weevils give off the same gas much more actively. In the air-tight receptacle completely filled with weevily wheat, the rapid evolution of carbonic acid, with the exhaustion or diminution of the small quantity of oxygen present in the air filling the interstices among the wheat grains, has a lethal effect on all the insects enclosed. And the greater the degree of the insect invasion, the more rapidly is the result brought about, owing to the corresponding rapidity with which the carbonic acid is produced and the oxygen exhausted.

The importance of these experiments, and of the experience of the methods of storage above referred to, as followed in parts of India and in Malta, to those in charge of the wheat storage in this country, will be at once apparent. In the storage for a time of weevil-infested grain in air-tight bins or silos, we seem to have a remedy which lies quite in the path of the normal process of bulk-handling. But before a rational scheme of treatment can be formulated, there is need of exact experiments on a large scale to determine how long wheat in which

weevils had made their appearance would need to be kept in the air-tight silo before the pests could be regarded as effectually disposed of.

A side-issue of considerable importance that has to be kept in view in determining the details of this course of treatment, is that special caution would have to be exercised in the case of grain that might come to be used as seed.* If the period during which wheat is kept in an air-tight receptacle be prolonged beyond a certain point, not only is all insect life destroyed, but the vitality of the wheat itself becomes imperilled; or, in more precise terms, its germinating capacity may be interfered with—may be, to all intents and purposes, destroyed. The degree of carbonic acid pressure, and the length of time necessary to bring about this result, are only ascertainable by large scale experiments, which have yet to be undertaken. But the data available are sufficient to point to the conclusion that wheat which may have to be used for seed purposes should not be kept in air-tight receptacles for any considerable period.

I have pleasure in acknowledging the assistance which I have received in compiling the foregoing statement from my colleagues of the Grain Pests Committee—Messrs. Leo. Rossell, W. W. Frogatt, and F. B. Guthrie.

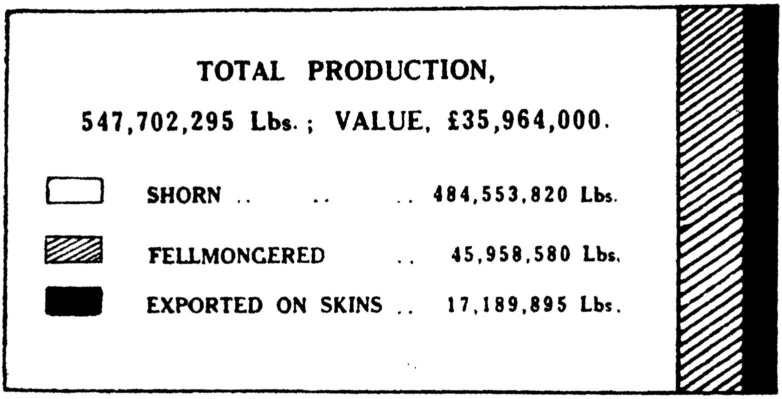
* Seed-wheat, reserved as such by the farmer, would not normally come under the silo system at all. But in times of scarcity advances of wheat for seed have often to be made, and it is to *potential* seed-wheat in this sense that reference is here made.

The Future of the Textile Industry in Australia.

By "BRADFORD."

AUSTRALIA is rightly famed for her wool, and the fact that such large quantities are grown here has led to considerable discussion as to the policy to be adopted by the country in relation to that commodity. An analysis of the various suggestions made in the press and elsewhere shows that there is a considerable lack of knowledge of fundamental facts, and that the position is often, either ignorantly or wilfully, misrepresented. It is seriously claimed by some writers and speakers that not one ounce of wool should be allowed to go out of the country in an unmanufactured state. The question as to whether this is practicable or not can be dismissed for the present. A more practical consideration is whether the manufacture of woollen goods cannot be considerably increased and more of local requirements supplied.

Wool Scouring.—First, however, it may be convenient to consider what appears a very plausible suggestion with regard to the form in which the wool shall be sent from Australia. It has been suggested that all the wool should first be scoured before being sent out of the country. It is a fact that, under



the Government control which has operated during the war period, there has been a considerable increase in scoured wool. This, however, has been directly due to the lack of shipping; and, with Government control removed, growers will be free once again to scour their wool or submit it for sale unscoured. Under conditions obtaining before the war, and which will doubtless obtain after the release of Government control, it is safe to assume that the trade did, and will, adopt that course which is in the best interests of the industry. Certain classes of wool can and should be scoured before shipment. Other classes, however, can be most satisfactorily dealt with in the grease.

For wools used in the manufacture of the lower class of woollens it is of little consequence to the manufacturer whether he receives the wool scoured or not. He will pay for it what it is worth to him, taking into account the amount of manufactured goods he expects to make from it. If it is in the grease, he has to make an allowance for the cost of scouring; if scoured, the allowance has not to be made. Even in this case it is questionable whether the unscientific methods of scouring adopted by some of the scourers is not a serious drawback, and probably results in the returns for the wool being reduced in consequence.

When we come to consider the wools used for better-class woollens and for worsteds the scouring of the wool here is not only superfluous, but, in many cases, detrimental alike to the interests of the grower and of the manufacturer.

Present Number of Employees.	Wool Scouring and Fellmongering	2,599
	Wool, Cotton and Tweed	3,755

Value of Australian Wool Production	£35,964,000
Estimated Value of Imports of Woollens	£5,925,158

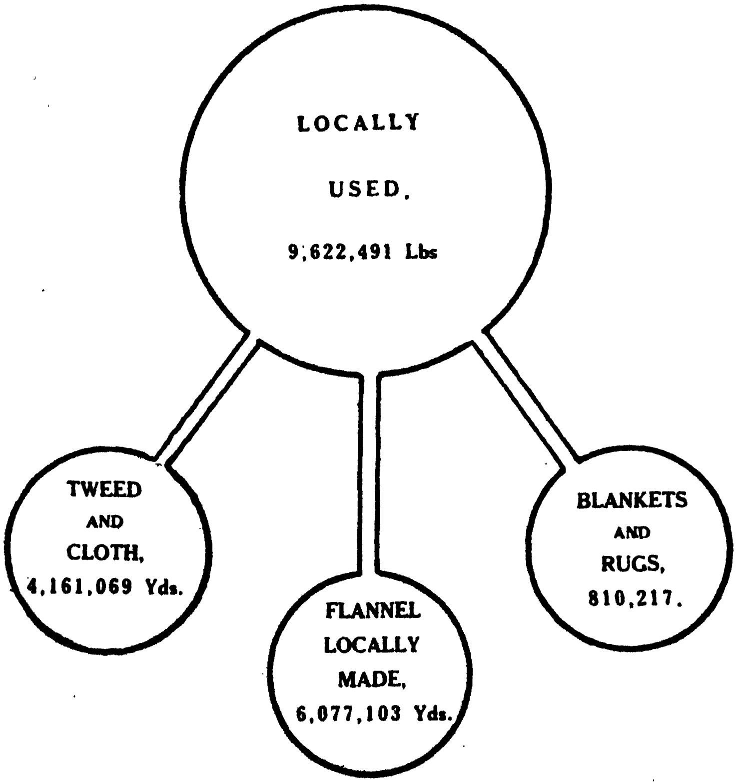
Wool Exported.		Lbs.
	Greasy	333,213,655
	Scoured	51,817,384
	Tops	4,869,452

Wool Scouring and Fellmongering.		£
	Value of Output	8,572,579
	Material Worked up	7,341,638
	Value Added in Process	1,230,941
	Cost of Land and Buildings	276,162
	Cost of Plant	369,728

Wool and Cotton Tweed Mills.		£
	Total Value of Output	1,948,151
	Value of Tops	1,204,570
	Value of Tweeds, &c.	743,581
	Material Worked up	1,076,641
	Value Added by Process	871,510

In the manufacture of these goods the wool, for various reasons, has to be scoured in the factory where it is to be manufactured, whether or not it has previously been so treated. Therefore, any saving in freight which might accrue in normal times is more than counterbalanced by this duplication of treatment. But there is another and far more serious objection. The natural grease or yolk in the wool is an excellent preservative of the qualities so essential for these goods, *i.e.*, softness to the touch and elasticity. Wool scoured here, packed and transported to the other side of the world, loses these qualities to a very considerable extent.

If the trade were compelled by legislative enactments to accept scoured wool when it prefers greasy it would have no option, but the growers of Australia would soon discover if it did not pay.

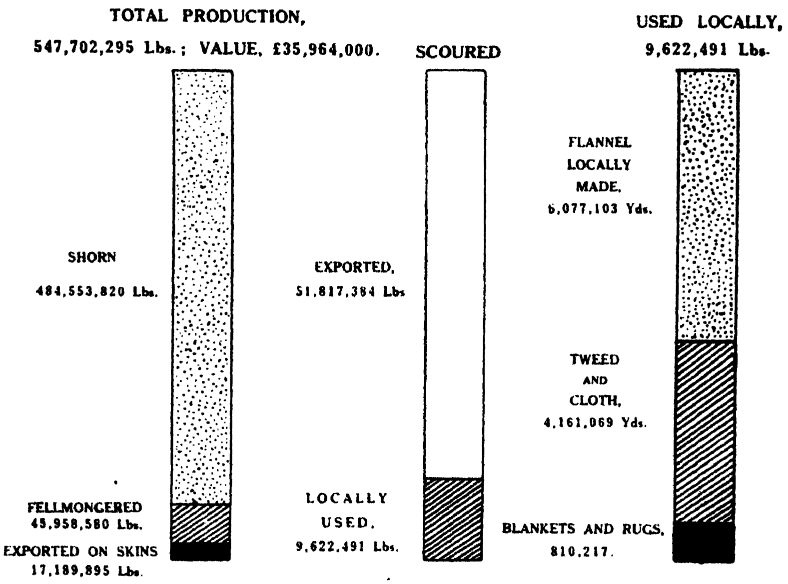


The first thing to be done with regard to the scouring of wool should be to discover what wools can with advantage be scoured, and then to see that the scouring is scientifically performed. Considerable damage to the wool, and consequent loss to the grower may and does result from the fact that this is not done. It is quite possible, by bad scouring, to so injure the wool that it will have to be used for inferior goods, and will therefore demand a lower price and reduce the return to the grower.

Other factors may at times have to be considered. For instance, at one time the duty on wool imported into Russia was the same per pound whether the wool was greasy or scoured. The result was that Russian buyers took only scoured wools, as it is obvious that a duty of, say, 3d. per lb. on greasy wool yielding only 40 to 50 per cent. of scoured wool was not nearly so good a paying proposition as 3d. per lb. on wool which would yield from 90 to 100 per cent. of clean wool. Under such circumstances it may conceivably be advantageous

to scour wool which would otherwise be better in the grease. Such cases as this, or other exceptional ones, the trade and the growers will be quick to discover and act upon, and therefore do not affect the general policy of the industry. The Government could assist materially by affording facilities for technical training, so that the scouring which can be done here may well and economically be done.

Wool Manufacture.—With regard to the conversion of wool into manufactured goods ready for use, it is of interest to note that, in the year before the commencement of the war (1913), the total value of the output of woollen and tweed mills in Australia amounted to £917,957. An analysis of the imports of textiles into Australia shows that the value of such manufactured articles as could well be manufactured here was over £4,000,000, or more than four times the value of the locally manufactured. While it is true that the value of such goods manufactured in Australia in 1916 had doubled, this was due largely to the increase in value, and only to a small extent to any increase in volume of goods manufactured. It is clear, therefore, that there is ample scope for development of the industry before that stage is reached, when it will be necessary to consider the disposal of any surplus after meeting local requirements.

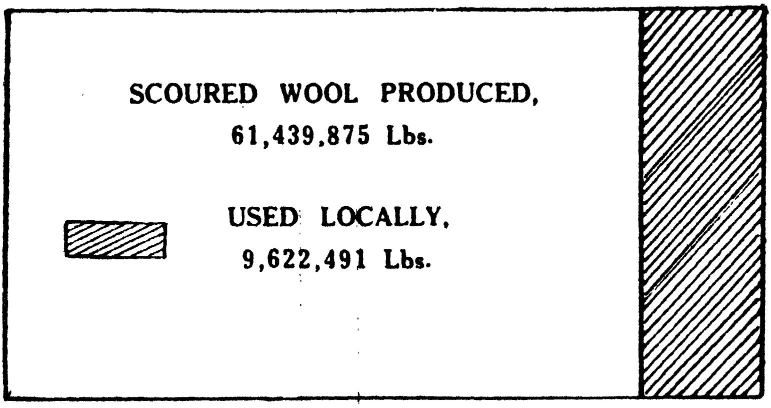


A considerable extension of the textile manufacturing industry may reasonably be expected. Already the industry is protected in two ways. The Australian manufacturer has not to pay freight, which, to the English manufacturer, is a considerable item. Further, the Australian manufacturer is protected by a substantial Customs Tariff. This substantial protection may not have been an unmixed blessing. The absence of any appreciable competition may have prevented the impetus to increased efficiency.

Technical Training.—It is probable that there is room for considerable increase in efficiency, and this can only be secured by the adoption of methods similar to those adopted by English manufacturers when threatened by Continental competition. They discovered that one of the reasons for the rise of this competition was the greater attention given to technical training on the Continent, and led to greater interest and development of such training in England. In all the centres of the textile manufacturing industry in England, there have been established technical schools or colleges, which have materially assisted the manufacturer by the adoption of better methods and increased efficiency to maintain his supremacy. In this country there is practically no

provision for this necessary supplementary aid to the training of manager, foremen, and operatives, and it is a deficiency which should be met if the industry is to develop as it should.

In the Technical College of Bradford, Yorkshire, the instruction provided for training in the principles of preparing, combing, and spinning of wool into yarn, covers three years' attendance at day lectures and practical experience. The course in weaving and designing covers a similar period, as also does the course in dyeing. This will convey some idea of the importance attached to technical training in the centre of the trade in England. Evening classes are provided for those engaged in the industry in the day time, and also cover a three years' course; but the courses are further subdivided so that those engaged in any particular branch of the industry may attend classes in which they can receive theoretical and practical training in the occupations they follow during



the day. Similar facilities, both as to day and evening courses, are provided at other centres, such as Leeds, Halifax, Huddersfield, &c. These colleges have only in recent years assumed the extent and importance they now hold. They have developed from small beginnings. For instance, in Halifax, the first attempt at this kind of instruction was made in connexion with the Mechanics' Institute and Literary Society over twenty years ago. The instruction was at first theoretical only, but the demand led to an increase in the facilities, and these were provided gradually, until in a few years a complete plant had been secured, and students were able to receive practical as well as theoretical instruction. The machinery necessary for the establishment of a Textile Technical College could be secured for an expenditure of about £3,000. If the industry is to develop on right lines, the establishment of such facilities for study and practice is absolutely essential.

Scientific thought does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.

—W. K. CLIFFORD.

Australian Leather.

ITS DEFECTS.

BY F. A. COOMBS.*

In the first place, I will deal with the export trade. This has been largely in the hands of a few exporters, who generally bought on commission for London firms, English wholesale firms who have agents in Australia, and one Australian firm who distribute their own leather in London.

Now, under these conditions, we find that, with few exceptions, the Australian tanners do not know where their leather goes after it reaches London. There are various rumours which seem to indicate that the Australian leather is retanned and finished as sole, harness, bridle, strap, kip, bag-leather, and a certain proportion is sold direct to the boot manufacturer.

One cannot say a great deal about the quality of the exported leather when one does not know what it is being used for when it reaches London, but I think that your Committee will agree that if we had this information Australian tanners would be in a better position to increase their export trade and place on the English markets finished leathers of such a quality that they could be sold direct to those manufacturers who produce leather goods.

Now, if we turn to the leather exported to England, we find that the majority of it goes Home as finished sole leather, and if it is not cut up and used as sole leather all the labour required to finish that class of leather could be returned as so much money wasted. This same labour could have been used to produce some of those lines mentioned above which give good wearing results when made from Australian leather.

Before the war the great majority of our sole-leather tanners did not pay much attention to the general public who wear the boots, but they devoted their energy to producing a profitable leather which also satisfied the requirements of the boot manufacturer. Now the boot manufacturer requires a cheap leather, and if the people were keen, and could detect an inferior leather, he would have to put a better leather in the boots, and the quality of sole leather would then be kept up to a higher standard, but as the people do not demand a good sole leather the standard must naturally be low.

I do not want you to get the impression that I think that all Australian sole leather is not up to a desirable standard, but I do not hesitate to say that a large proportion is inferior as regards quality. The production of this inferior leather is probably due to the fact that there is a big demand for it. To produce this cheap leather the tanner reduced the time for the tanning process, and fills up the leather with extract and glucose.

There is no doubt that a large proportion of this inferior leather has been exported to England, and those men, who are advising the British Government as to the most suitable leather for military boots, certainly know that this particular leather will not give desirable results, especially in a wet climate. There is no doubt in my mind that the British leather experts know the quality of this leather, and if they condemn it for military purposes they could hardly allow it to be used for civilian boots.

Now, if my statements are correct, it is not a fair proposition for us to expect the people in a wet climate like England or the soldiers in France to wear this leather on the soles of their boots. Such a leather in a wet climate would absorb water quickly, and open up to the undesirable soft condition it was in before the rolling process. We must also note that of all the various tanning materials few produce a leather which offers less resistance to water penetration than wattle-bark. So that, since the war started, we have been producing a light or thin sole leather which does not reach a high standard as regards its resistance to the penetration of water, and we have sent this leather to a country where there has been a big demand for a heavy or thick sole leather, capable of offering a great resistance to the penetration of water.

* Report furnished by Mr. Coombs, of the Sydney Technical College, to the Institute of Science and Industry.

If the Australian tanning industry had been thoroughly organized at the beginning of the war, Australia would now have been producing and exporting all classes of military leathers, with the single exception of light sole leather, for a wet climate.

I would suggest that certain work be carried out to improve the quality of sole leather, if it be necessary, from an economic stand-point, for Australia to export this leather.

If the Federal Government were to adopt the following suggestions for the control of the manufacturing process for producing sole leather for military boots, then I think we could claim to be making a start to produce a standardized Australian sole leather of good quality:—

(1) No glucose or sugar to be added to this leather. Tanners are requested to note that glucose cannot be used in small quantities as a finishing agent.

(2) Leather tanned after the fibre has been abnormally swollen by the aid of sulphuric acid will not be accepted for military sole leather.

(3) Leather for military sole leather must not be exposed to the air for drying purposes and then placed in strong solutions of tanning extracts.

(4) The ash must not exceed 2.5 per cent. of the total leather.

(5) This leather may contain 8 per cent. fatty matter.

(6) A red-coloured leather will not be rejected providing the quality is up to standard.

I feel sure that if a certain proportion of pine-bark were used in a mixed tannage a leather would be obtained which would offer a good resistance to water penetration. To obtain profitable results from pine-bark the tannins would have to be sold in the form of an extract. I think the manufacture of an extract from pine-bark is of sufficient importance to put before your Committee as a problem requiring an investigation.

Summary and Suggestions.

(1) A proportion of Australian sole leather for the export trade contains water soluble substances which prevent it from offering a reasonable resistance to water penetration.

(2) That under normal conditions a wattle-bark tannage does not produce a leather capable of offering a good resistance to water penetration.

(3) The water-resisting properties of Australian leather could be improved by using more solid fats and a mixed tannage containing pine-bark tannins.

(4) The Federal Government could help to improve the quality of Australian sole leather by demanding that certain faulty methods be left out of the process for manufacturing military sole leather.

(5) That Australian leather would give good results in a wet or dry climate if used for the manufacture of strap, kip, harness, accoutrement leather, &c.

(6) That it should be pointed out to those persons controlling the importation of leather to Britain that the Australian tanneries could supply large quantities of the leathers mentioned above.

(7) Australian sole leather now held by local tanners would probably give good results if it were cut into soles and then dipped into solid fats or waxes at a temperature above the melting point. I would expect a leather treated in this way to give improved results in Egypt, Arabia, or any of the dry climates, and probably it would be quite suitable for the soldiers in France.

(8) That much valuable information is probably in the hands of the Federal authorities *re* the results obtained from Australian leather under actual war conditions, and that this information would be very useful to those persons who are interested in the scientific side of this industry.

(9) If the above suggestions were considered to be of sufficient value, I would suggest a small committee be formed to report on their economic value.

Such a committee could be expected to offer more suggestions, and improve on those mentioned above.

Personal.

PROFESSOR THOMAS RANKEN LYLE, M.A., Sc.D., F.R.S.

The North of Ireland seems to be a natural nursery for mathematical physicists; Lord Kelvin, Sir Joseph Larmor, Sir Joseph J. Thomson, are cases in point; so is the subject of the present notice. If his work has bulked less largely in the public eye than that of his distinguished fellow countrymen, the circumstance is due to the nature of the work itself and the conditions under which it had to be done, rather than the quality or amount of it. For Professor Lyle has done a vast amount of work both as teacher and investigator, and his work is of the kind that lasts.

He received his early scientific training at Trinity College, Dublin, under the eye of Professor Fitzgerald, one of the most original scientific thinkers of his day, and graduated with the highest honours both in mathematics and physics. Shortly afterwards, he was appointed, on Fitzgerald's recommendation, by the authorities of the Trinity House, to carry out some important work on lighthouse illumination; and in 1889 was elected to the Chair of Natural Philosophy in the University of Melbourne, defeating in the competition such well-known workers as Gee and A. Gray. The first twelve years of his tenure of office were devoted to the erection and gradual organization of his department This business left him comparatively little leisure for research, and of that little a very large proportion was given to the helping of other workers; nearly every physicist in Australia appealed to him for assistance on the mathematical side of their common work, and never appealed in vain. But this great task once accomplished, he threw himself with extraordinary energy into the work of mathematical and experimental research; even the onset of a serious illness, from the effects of which he continued to suffer for more than sixteen years, appeared to act rather as a spur than as a check. In his researches he displayed great powers as an inventor and mechanic, as well as an investigator; most of the apparatus he used was designed and a good deal of it actually made by him; its quality is attested by the fact that the National Physical Laboratory had some of it copied for use in the research work of that institution. His principal experimental researches dealt with the phenomena and laws of magnetization; his theoretical work with the computation of the electrical constants of wire coils and with the laws governing the behaviour of alternating currents. Incidentally he worked out and published the only complete theory of the alternate current dynamo yet put forward. This great memoir is a veritable marvel, both of mathematical skill and physical acumen; that it has not yet found its way into the text-books is a striking example of the inadequate training hitherto given to electrical engineers; they have hardly been educated up to its level!

The stimulating effect of his teaching and research has been marked. Professors Himmy, Grant, Barnard, and Hamley, Dr. Rosenhain (of the Natural Physical Laboratory), and Dr. Baldwin (Government Astronomer for Victoria), all won their spurs as research students in his laboratory; many more of his old pupils occupy important posts in the universities and high schools of various parts of the Empire.

Of the honours which have, as a matter of course, fallen to his share, two gave him exceptional pleasure; the first was his election as Doctor of Science of the Dublin University without payment of fees—a very unusual distinction—the second was his Fellowship of the Royal Society.

In 1914 he resigned his chair at the University; but, in common parlance, he "left off work to carry a hod," for his public activities are numerous and unceasing. At the outbreak of the war he became a member of the Federal Munitions Committee, and subsequently President of the Industries Exemption Advisory Committee. When the *Cumberland* was lost, the Prime Minister intrusted to him the investigation of the circumstances which led to the loss; mine sweeping round our coasts followed hard on his report. On the establishment of the Institute of Science and Industry he was appointed to its Executive, and also as Chairman both of the Victorian Committee and of the Alcohol Committee. Both the State Government and the University promptly annexed the balance of his time; the former has long utilized his services as Chairman of the Board of Visitors to the Observatory and on the Advisory Committee for Technical School appointments, and more recently as Vice-President of the Council of Education and Chairman of the Electricity Commission; the latter elected him to its Council. He also holds the important position of Scientific Adviser to the Naval Board. In spite of all these activities he still finds time for original research on purely scientific lines.

Professor Lyle has always been keenly interested in sport. In his early days he was an excellent cricketer and one of the best footballers in Ireland; though seldom seen in the playing fields of Australia, save as judge or referee, he has done, and is still doing, much to stimulate and encourage those clean, healthy exercises which help to build up our national manhood.

But it is not as teacher, investigator, or scientific adviser that Professor Lyle will be best remembered, either by his personal staff or by the thousands of students who have passed through his department. His sound judgment, wise counsels, generous friendship, and unerring tact have won for him, not merely their reverence, but their very real affection. His portrait, subscribed for and presented by past and present students, hangs—permanently, they hope—on the walls of the Laboratory in which he worked; but it is their tribute, not their reminder.

E.F.J.L.

Mr. C. J. Sanderson, M.R.C.V.S. has been appointed Chairman of the New South Wales Tick Board, which is to control tick administration on the northern rivers. Mr. Sanderson has had wide experience of stock diseases in New Zealand, South Africa, and Australia. He entered the service of the New South Wales Department of Agriculture in 1909 as a veterinary surgeon, and during the five years he held that position he did a considerable amount of work in the investigation of diseases of stock. In 1914 he was sent to Europe to purchase stud stock for the Government, and on his return he was appointed Manager of the North Bangaroo Stud Farm, which position he has held since the beginning of 1916.

PERSONAL.

The news of the death of Mr. Daniel Wienholt, which occurred at Brisbane on the 22nd August, will come as a shock to his numerous friends, by whom he was held in the highest esteem. Mr. Wienholt was a member of the Advisory Council of Science and Industry, and took an active interest in the work of the Queensland State Committee. He was fifty-three years of age, and was born at Blythedale Station, near Roma. He was educated at Harrow, England, and returned to Queensland when he was eighteen years old. After gaining station experience, he was manager of Warenda Station, and had a great deal to do with the development of the cattle industry. Mr. Wienholt took a keen interest in public affairs, including politics, and more than once was pressed to stand in the Liberal interest, but never saw his way to entering the political arena. His ardent patriotism was manifested at the outbreak of war, and there was no more active worker than he in the cause of the various war efforts, on behalf of which he rendered notable service.

Professor Woolnough has resigned his position as Professor of Biology at the University of Western Australia. It will be remembered that last year Professor Woolnough furnished a report to Messrs Brunner, Mond & Co., England, on the alkali possibilities of Western Australia. At the request of that company, he subsequently went to England to discuss the question with them.

Dr. W. J. Young, formerly bio-chemist at the Australian Institute of Tropical Medicine, Townsville, has been appointed lecturer on bio-chemistry at the University of Melbourne. Dr. Young has written numerous articles embodying the results of original investigations in chemistry, and especially organic chemistry. More recently, his published writings have dealt with various problems arising from the result of tropical climatic conditions on white races.

Mr. A. B. Piddington, K.C., Chief Inter-State Commissioner, has returned to Melbourne from Queensland, where he has been engaged on the Sugar Inquiry. Since his return, he has been present at the Executive Committee's meetings.

Mr. D. Avery has recovered from his serious illness, and has resumed his work for the Institute as a member of the Executive Committee.

Dr. W. W. A. Sawyer, Senior State Director to the Rockefeller Foundation, U.S.A., has arrived in Australia to commence the campaign against hook worm, which is so prevalent in the tropical parts of Queensland and constitutes a serious menace to white settlement. Hopes are entertained that it will be found practicable to completely stamp out the disease. In attacking the hook worm, a further purpose will be served of reducing the risks that have to be faced with regard to epidemics of typhoid and outbreaks of dysentery, as the first step in the campaign will be to improve sanitary conditions.

REVIEWS.

"INDUSTRIAL CHEMISTRY."

A SERIES OF MONOGRAPHS, Edited by Samuel Rideal, D.Sc., F.I.C.

(London: Bailliere Tindall & Cox, 1918.)

One great result of the war has been the revolutionary changes in all branches of Technology, brought about by the rapid developments in applied chemistry, engineering, sanitation, aeronautics, &c. The present series of monographs aims at giving a general survey of applied chemistry treated from the chemical rather than from the engineering stand-point. Each volume is complete in itself, and is divided into sections, each of which is also a complete article on the subject it contains. A selected bibliography is attached to each section, and a general bibliography of the whole industry is provided, which, it is hoped, will serve as a guide to the standard literature of the whole subject.

Present tendencies and possible future developments are indicated. The volumes are written by specialists connected with the various industries, who thus supply the link which has been so much praised in Germany's industrial organization.

The Editor establishes a difficult ideal to be realized when he endeavours, at one and the same time, to cater for the needs of—

1. The man of affairs having no special technical knowledge;
2. The advanced student whose mind, crammed with chemical facts, is unable to realize the industry as a whole; and
3. Those actually engaged in the industry who have specialized in rather narrow limits, and who desire a little more knowledge of their subject generally.

Messrs. Angus and Robertson, Sydney, have supplied copies of five volumes already issued, viz.:—

(1) *The Alkali Industry*, by J. R. Partington, M.Sc., Assistant in the Chemical Department, University of Manchester. (Pp. XVI. + 304, with 63 text figures. February, 1918.)

(2) *Coal Tar Dyes and Intermediates*, by E. de Barry Barnett, B.Sc. (London), A.I.C. (Pp. XVIII. + 213. January, 1919.)

(3) *Dyeing with Coal Tar Dyestuff*, by C. M. Whittaker, B.Sc. (Pp. XII. + 214. June, 1918.)

(4) *Industrial Electro-Metallurgy*, including Electrolytic and Electro-thermal Processes, by Eric K. Rideal, M.A. (Cant.), Ph.D., F.I.C. (Pp. XII + 247. June, 1918.)

(5) *Plant Products and Chemical Fertilizers*, by S. Hoare Collins, M.Sc., F.I.C. (Pp. XVI. + 236. February, 1918.)

(1) Probably the first thing that strikes one's attention is the inclusion of sulphuric and nitric acid and chlorine in the alkali industry. These together occupy nearly one-third of the book, with the result that other subjects become crowded out. The relative amounts of space appear to have been irregularly allotted. One idea of treating chemistry and other science subjects in compact, monographic series, is that the volumes can be kept up-to-date better than a large text book, and that small books are much more convenient to handle. We hope to see in the future more space devoted to electrolytic processes (8 pages), bleaching powder (4 pages), magnesium and its salts (2 pages), and some other sources of potash, which vitally concern agriculture throughout the

British Empire. The book represents a great amount of careful work, especially in compiling the references, though some of these show a small proportion of quite recent date; for example, on chlorine the most recent is 1907, and only twelve out of 52 date after 1900. In nitric acid, 7 of 48 are after 1914. In other respects, also, information does not appear always up-to-date. No mention is made of a paper published by the United States Government on synthetic nitric acid, in which the most reliable figures of costs are given. No mention is made of new methods adopted in Germany of preparing ammonium sulphate from ammonia and gypsum.

We think that the fault has been of attempting to cover too many industries in such a small volume, but there is sufficient material to form at least two volumes. No less than 63 clearly-drawn figures help to explain the text.

(2) A large part of this book is occupied with an account of the manufacture of intermediate products from which the more important synthetic dyes are manufactured. This is as it should be, when we consider that over 80 per cent. of the capital outlay in a dyeworks is in plant for the production of intermediates. The author states that no attempt has been made to enumerate all the intermediate compounds and dyes, yet we would like to see some mention of isatin, which is of historic importance. Investigations of isatin by Baeyer finally led to the elucidation of the constitution of indigo. Also, no mention is made of the nitro-benzaldehydes, from the meta compound of which various patent blues and fast green are manufactured.

The various patent processes for the catalytic reduction of nitro-benzene to aniline are stated by the author to have not yet reached commercial success, yet a process with copper has been worked on a commercial manufacturing scale by the German firm of Badische Anilin und Soda-Fabrik, and with nickel Lucius and Brüning get a yield almost equal to the theoretical. In this and the next volume, we would like to see the German term "dyestuffs" abolished, substituting "dyes" alone; and the other terms "benzole and toluole" replaced by the more modern "benzene and toluene."

The literature is extensive and well selected.

(3) The position of the author, as head of the experimental dye house of British Dyes Limited, is sufficient guarantee of the accuracy and first-hand practical knowledge of the subject. The chemical principles involved, and the methods used in the applications of the dyes, are clearly set out in such a way that one may readily understand the subject. This volume, more so than all the others, conforms to the Editor's ideals as stated above. A good historical survey, showing the gradual growth of the industry and the present influences and tendencies, are clearly stated. The subjects covered include the basic and acid dyes, the alizarine and other mordant dyes, the direct cotton dyes, the azo and sulphur dyes, and indigo and other vat dyes. The enormous extension in the dyeing of mixed fabrics of silk, wool, cotton, and artificial silk, must be credited to the direct cotton dyes, whilst the increasing success of present-day garment dyeing is directly attributable to the same colours. On cotton, we read that the anthracine vat dyes are fast, that the azo dyes rub and sub-lime off the fibre, and that indigo on wool is the standard of fastness for blues on wool, and that there are no bright scarlet, crimson, or violet dyes in the sulphur group.

The demand for cheap new clothes often, instead of long-lasting expensive ones, has led to great advances in the dyeing of garments of mixed fabrics.

An unusually difficult subject has been treated in a most readable and interesting manner, without introducing very much theory. The book should be in the hands of every person in any way connected with dyeing, and, moreover, many recipes can be found of value to other traders, such as inkmakers, confectioners, tanners, and furriers. The whole section on the dyeing of union materials would form a useful handbook for all dyers and cleaners.

(4) This volume also conforms to the high ideals of the Editor. Each section is complete in itself, and the various parts might readily form separate booklets. The subjects covered include fertilizers, soils, crops, and the production of meat. The extensive bibliography throughout is very good, most of the references being quite up-to-date. The law of diminishing returns, mentioned on page 83, taken from the Rothamsted results, are equally applicable to Australia in the case of the use of superphosphate as a wheat manure. The use of mixed fertilizers, as given in section 4, does not apply so much to Australia as England. Natural

manures are not used to the extent here that they should be. Similarly, the references to potash are much under-rated for Australian use. The section on the use of electricity on plant stimulation could be much more fully developed, and so also the sections on partial sterilization of soils and the use of lime.

The part dealing with crops gives a miscellaneous mixture dealing with the production of carbohydrates and oils, followed by a conclusion dealing with tea and cocoa, rubber and indigo, &c. The fourth section is more physiological in its nature, dealing chiefly with the varieties and values of various animal foods. A final section on the future development in agriculture is a useful and opportune contribution to the question of increased agricultural production.

The whole book, though somewhat disconnected, is a useful and readable summary of many agricultural problems.

(5) At the present time the great need throughout the Empire is economy in the use of coal, and this has set in motion many investigations on power supply. A cheap and economical supply of electricity will give a great impetus to the electrochemical industries, especially the refining of metals, the manufacture of alloys, the production of fertilizers, explosives, &c.

This book will serve as a good general account of the subject, and has appeared at a most opportune time. The text is illustrated with many clear drawings, and there is a useful bibliography.

The subjects covered include electrolysis in aqueous solutions, and in fused electrolytes, the electrolytic preparation of the rarer metals, electrothermal processes, carborundum, carbides, nitrogen fixation by metals and metallic compounds like cyanimide, and iron and ferro-alloys.

Throughout the Commonwealth at the present time, there are several proposals for the production of electric power on an extensive scale, *e.g.*, in New South Wales, Northern Tableland and coast, and in Tasmania there is already a large scheme in operation. This book should form the groundwork for information or processes that will undoubtedly soon develop very largely in Australia.

"It is certain that henceforth the most powerful nation will be, not that which possesses the most extensive territory, nor that which has the largest population, but that which is most industrious, most skilful, best educated, most capable of utilizing all the means and forces that science can place at man's disposal, and which enable him to triumph over matter. The greatest producer amongst nations may become the foremost power of the world." Those words are taken from a report of a French Commission on Technical Education, which was issued in 1863.

From Report of a French Commission on Technical Education quoted by Hon. L. E. Groom, M.P., in his second-reading speech on the Science and Industry Bill.

The Late Dr. F. M. GELLATLY.
First Director of the Institute of Science and Industry.

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Death of Dr. Gellatly.

Since the last issue of this journal appeared, the death has occurred of Francis Mephan Gellatly, LL.D., Director of the Institute of Science and Industry. He passed away at North Sydney on 24th September. Poignant regret, and wide-spread sympathy with his family, were evoked by the announcement in the daily press, and many sincere tributes were paid to his rare personal and intellectual qualities. Pneumonic influenza cut short his promising career, and deprived the Commonwealth of one of its most valued servants. That he was destined by his brilliant gifts to bring honour and distinction to the Institute none who were closely associated with him in his work will deny. The first impressions which he left upon all acquainted with him were those of a man possessed of a kindly, sunny disposition, of a sound judgment, and of power born of ability. These impressions quickly crystallized into a firm belief. His every act fully justified the confidence that was reposed in him.

Dr. Gellatly was born at Ballarat, and was educated at the Church of England Grammar School, Ballarat, the King's School, Parramatta, and the Sydney University. In 1891 he joined the New South Wales Forestry Department as a forest cadet, and worked for some time at various State nurseries. However, his hand itched for the pen, and a year or two later he entered upon journalism. Shortly before his retirement from the press two series of articles which he wrote attracted particular attention. One dealt with repatriation problems, and the

other was entitled "Big War Deals." He was generally recognised as one of the soundest financial authorities in Australia, and he was an unsparing critic of prospectuses of ventures which asked, on slender grounds, for the support of public money. In 1917 Dr. Gellatly was unanimously chosen as chairman of the New South Wales Journalists Board of Advice, by the newspaper proprietors, and by the Institute of Journalists. Dr. Gellatly was but 46 years of age at the time of his death. He is survived by his wife, two sons, and three daughters. The eldest of his daughters has just commenced a science course at the Sydney University.

The wide experience which Dr. Gellatly gained in journalism, and his advanced legal training, provided him with an invaluable mental equipment for the position for which the Commonwealth Government selected him. A scheme for the creation of an Institute of Science and Industry had been elaborated, but, pending parliamentary indorsement, its permanent establishment was postponed. In June, 1918, Dr. Gellatly was intrusted, as Chairman of Directors of the future permanent Institute, with the task of organizing the industrial scientific investigations of the Commonwealth. In this work he was assisted by the Executive Committee of the Advisory Council, which, since the temporary inauguration of the Institute in 1916, had been carrying on its duties in the face of great difficulties. The appointment of a permanent administrative officer greatly stimulated the activities of the Institute, for it immediately became apparent that a wise selection had been made. The wide and intimate knowledge of affairs which Dr. Gellatly had gained during his connexion with the business community, combined with his tact and imagination, peculiarly fitted him for bringing together in cordial co-operation the working elements of the Commonwealth. He applied himself whole-heartedly and unsparingly to his new duties. His first visit to the various States yielded a rich harvest of good results.

One of the cardinal objects of the Institute is to co-ordinate the experimental work of the States. The intention is not to link up the States under the Commonwealth, but to link up the States with the Commonwealth. In this aspect of the work Dr. Gellatly was conspicuously successful. Science has no boundaries, and in the interests of efficiency and economy, national needs must be the first consideration. The co-operation of the Queensland Government towards the eradication of the prickly pear had been obtained, and he completed the scheme by obtaining the co-operation of the New South Wales Government. As a result, an agreement has been arrived at by which the Commonwealth undertakes to expend £4,000 per annum for a period of five years, and each of the two States £2,000 per annum for the same period.

DEATH OF DR. GELLATLY.

Plant and animal diseases which annually levy such a huge toll upon the primary industries do not restrict their ravages to any one State. They devastate the crops and decimate the herds of the whole of Australia. The States realized the necessity of co-operative investigations, but it was due largely to Dr. Gellatly that many important inquiries were co-ordinated, new investigations commenced, and a harmonious conjuction of interests established. Co-operative work in investigating the white ant, blow-fly, and numerous other pests has been undertaken, and a wider field of industrial research has been opened up. Investigation into tanning processes, viticultural and irrigation problems, and the introduction of new economic plants represent only a portion of the work upon which the Institute and State organizations are concentrating for the common good.

Almost every one in Australia is familiar with the story of the reckless and wanton waste of our forest wealth. With our natural assets so seriously depleted, no endeavour was being made to ascertain the best economic uses to which the remnants of our magnificent timbers might be applied. Dr. Gellatly placed this work in the forefront of the programme of original investigation which the Institute should carry out. He worked hard for the creation of a National Forests Products Laboratory, and met with generous support from the Western Australian Government, which offered the Institute a sum of £5,000 towards the capital cost of the undertaking. Notwithstanding the fact that the vegetation of the Commonwealth is highly peculiar, and that a great number of grasses and the most widely distributed plants, including the genus eucalyptus, are quite different from those of other countries, Australia still lacks the scientific staff and apparatus for enabling research work to be carried out.

Investigation into problems affecting primary industries constitutes but a portion of the work mapped out for the Institute. Dr. Gellatly strove hard for the establishment of a National Physical Laboratory for industrial research as distinct from laboratories designed primarily for teaching purposes or for routine testing. His advocacy of this step brought upon him, and upon the Institute, a great deal of stupid and unscrupulous criticism from a section of the community. The last editorial which he wrote for *Science and Industry* was an effective reply to the uninformed criticism levelled against the Institute and against himself. The fact that every country of any industrial eminence at the present time—Great Britain, the United States, France, and Japan—is working along similar lines to those which it is the policy of the Institute to proceed, and that Germany owed her pre-war industrial efficiency primarily to the encouragement given to scientific research for the advancement of industry, was studiously ignored by the opponents of the scheme. It was in his attitude towards

these bitter attacks that Dr. Gellatly displayed a true quality of greatness. He possessed a sense of proportion which rendered him indifferent to criticism designed merely to hurt and destroy. On the other hand, he was eager to benefit from criticism of a frank and friendly nature designed to assist the Commonwealth in equipping itself for the struggle for industrial and economic supremacy which is now being entered upon. In this connexion, it is noteworthy that Canada, New Zealand, and South Africa are adopting similar measures to those which Great Britain has already given effect to, and which Japan, quick to seize upon every means for strengthening her commercial position, has closely imitated.

In the editorial referred to Dr. Gellatly pointed out that the Institute has more than justified itself for several years to come as the result of the work it has done in standardizing steel. Already the standardization has been effected of structural steel sections, of railway rails and fish-plates, and of tramway rails and fish-plates, and the newly-born steel industry of Australia has been given assistance of tremendous value towards meeting the competition of huge and wealthy overseas corporations. And these three achievements represent only the first instalment of the Institute's contribution to industry. Engineering standardization, which has so greatly helped to build up the gigantic basic industries of the United States and of Germany, and which is also being applied to British industry, has already been invested with new interest to Australian manufacturers, and many requests have been made to the Institute to assist towards the standardization of the industrial elements.

Other matters to which passing reference must be made, which Dr. Gellatly has particularly interested himself with since his connexion with the Institute, are the establishment of a scientific and industrial library, the creation of a Bureau of Information, and the establishment of this journal. All three are receiving more and more public support, and must prove of material benefit to the scientific workers of the Commonwealth. That the Institute has been able to accomplish so much when it has been compelled, owing to its temporary organization, to restrict its energies mainly to the co-ordination of research, indicates the wide field of usefulness which awaits the advent of a permanently established and a completely organized and equipped Institute of Science and Industry.

Dr. Gellatly was a Doctor of Laws of Sydney University, and a barrister-at-law of the New South Wales Bar of seven years' standing. This high academic honour which he won, and the manner in which he won it, throws an interesting sidelight upon his character. During the time he was working for his examinations he was carrying out his

onerous and responsible duties as financial editor of the *Sydney Morning Herald,* but he took them both in his stride, and was successful in each. To most men, with either the one or the other duties to fulfil, the task would have proved a trying ordeal. He took his success modestly and lightly. Like all truly busy and active men, he was never so busy that he could not find time for additional work. His unassuming air, his quiet demeanour, and his kindly nature to a great extent concealed his great capacity for work, and it was not until he had accomplished some particularly difficult task that his closest friends knew that he had even been engaged upon it. To the staff of the Institute he was guide, philosopher, and friend, and the work which he got from all his associates was instinctive, not propitiatory. It was his blend of the *suaviter in modo, fortiter in re,* which evoked honest and willing labour.

The Executive Committee of the Advisory Council of Science and Industry has expressed its appreciation of the late Director in the following terms:—

> "That the Executive Committee desires to record its high appreciation of the valuable services rendered to the Institute by its first Director, the late Dr. Gellatly, and its sense of the severe loss the Institute and the Commonwealth have sustained by his untimely death. The Committee feels deeply that the Australian movement for bringing Science to bear upon the practical problem of Industry will always owe a debt to the untiring energy, the alertness of intellect, the wise and moderate counsels and the sympathetic temperament of the late Director."

Spiritual truth was the living force that turned the face of man toward the towering peaks of a true civilization; science the lamp by which he could guide his feet towards this distant goal.

—*W. M. HUGHES.*

EDITORIAL

MILITARY GAS MASKS FOR RESCUE WORK IN MINES.

The Chemicals Committee of the Institute has considered a suggestion by Mr. C. H. Blakemore, Mining Engineer, Sydney, that military gas masks might be used for rescue work in mines.

There are certain mines where the fire danger is a serious one, such as in the mines of the Broken Hill district, which are heavily timbered with a very inflammable wood, and their history already contains several serious fires accompanied with loss of life.

Mr. Blakemore states—"There are other mines which possess ore of a class that, under certain circumstances, will take fire spontaneously due to chemical decomposition. I know of at least three copper mines in New South Wales where such fires—I might call them chemical fires —have occurred.

"There are only known to us to-day such things as the Draeger Smoke Helmet, a thing which is very heavy to carry and which requires some considerable training to make it safe for the wearers. A further disability is the expense of the fitting. Now, it appears to me that the Military Gas Helmet which I have seen is light in weight, is easily adjusted, and is cheap in construction. It was capable of excluding such deadly gases as phosgene, and, with a little experimenting, might be made capable of being used in air which contains either CO_2, CO, SO_2, or SO_3, no matter in what quantity."

He suggests that these light, cheap, and easily-adjusted gas masks could be provided in quantity to enable a number of men to take part in the rescue work; a filtering medium or absorbent could be used that would free the air from any of the above gases, and possibly a small cylinder of compressed oxygen could also be carried for use in cases where the oxygen has been reduced below the amount necessary to support life.

The Chemicals Committee reports that, though this suggestion is a very important one and worthy of consideration, it is, unless considerably modified, open to the fatal objection that the gas masks charged with any ordinary absorbent are absolutely useless as a protection against carbon monoxide, and the first indication of the presence of this gas would be the collapse of the wearer.

All the latest models of army gas masks (British and American) consist essentially of—

(*a*) a mask, fitted with goggles, nose clip, and mouth-piece;
(*b*) a connecting tube with valves; and
(*c*) a canister filled with absorbent chemicals.

It is interesting to note that the first of this type was the Melbourne University Box Respirator; minor improvements have been added to the

later models, making them more convenient to use and wear, and the soda-lime employed as an absorbent has been supplemented by the addition of nut charcoal and potassium permanganate, in order to protect the men against the numerous poison gases, such as "tear gas," "sneezing gas," and "mustard gas," which followed the original chlorine gas attacks.

For industrial purposes at chemical and other works, the gases likely to be met with are—(*a*) chlorine; (*b*) acidic gases, such as sulphur dioxide, nitric oxides, and prussic acid; (*c*) special chemicals, such as formaldehyde; and (*d*) carbon monoxide.

Chlorine and the acidic gases are readily absorbed by the soda-lime used in these masks, and any of the standard types can be relied on to protect a worker without discomfort for at least an hour in an atmosphere containing up to 1 per cent. of chlorine or the acid gases mentioned.

Formaldehyde, like acidic gases, irritates the mucous membranes around the eyes as well as in the throat and lungs. Goggles are here an essential for the protection of the eyes, and special absorbents are required to render the air fit for respiration in each special case. The difficulty, if not impossibility, of absorbing carbon monoxide puts it in a class by itself; and, unfortunately, its occurrence is by no means uncommon. It may be expected to be formed in any conflagration wherever there is insufficient oxygen for the complete combustion of the fuel. The Chemicals Committee is considering the question as to the desirability of instituting experimental work with a view to devising a mask effective against carbon monoxide.

All fires in mines and in enclosed spaces may, therefore, not only use up the oxygen of the air, but also convert more or less of it into the very poisonous gas—carbon monoxide—and protection can only be obtained by the use of an apparatus which provides an independent supply of oxygen.

A number of types of rescue apparatus has been devised and used for this purpose, and a recent report by a Committee of the British Department of Scientific and Industrial Research gives a very complete account of them, and also of the system under which they are used at some score of rescue stations distributed over England and Scotland. They are all complicated, expensive, and heavy, and can be only little less uncomfortable to wear than a complete diver's suit, but their value lies in the fact that they enable work to be carried out under conditions, and in situations, where life would otherwise be impossible.

The Proto, Meco, Draeger, and Weg apparatus are all in common use; they weigh from 36 to 40 lbs., and include a cylinder of compressed oxygen. A more recent apparatus, the Aerophor, is charged with 8 to 10 lbs. of liquid air (60 per cent. oxygen). Several other patterns have been suggested or patented, but have not come into use for rescue work in Great Britain.

Such rescue appliances are useless unless worn by properly-selected and thoroughly-instructed men, and several fatal accidents have occurred. The British Committee makes several recommendations as to rescue station routine and organisation. Expert chemical and medical control are essential for safety.

The possibility of making industrial use of surplus military gas masks has received attention in both England and America, and papers describing their construction, and giving information as to their capabilities, are to be found in *Eng. Mining Jour.* (1919) 107, pp. 693-5, and in *Jour. Ind. and Eng. Chem.* (1919), pp. 420, 519, and 622. The question is also being considered by a Committee appointed by the Broken Hill Mining Managers' Association, and the Institute has asked the Defence Department to obtain for experimental purpose a number of masks of the latest type of box respirator.

The Chemicals Committee emphasises the following aspects of rescue or emergency work in polluted atmospheres:—

1. The only generally safe apparatus are those provided with an independent oxygen supply. They must be worn by trained men.
2. In many chemical works, where the air is known to be free from carbon monoxide, but contaminated by small amounts of acidic gases, any standard pattern of Army gas mask will afford protection if care is taken that the absorbent chemical be not exhausted. Several sets should be available at chemical works in case of emergency; but a warning is issued against their indiscriminate use for any or all purposes.
3. Men are sometimes required to work in spaces charged with irritating dust or smoke. Relief can be obtained by the use of motor goggles to protect the eyes, and a mask (readily improvided) of cotton wool or even cloth over the mouth and nose to filter the air as it is inhaled.

SCIENCE AND INDUSTRY IN NEW ZEALAND.

The Industries Committee of the New Zealand House of Representatives has made the following recommendations for the creation of a Board of Science and Industry:—

(1) That a Board of Science and Industry be established for the development of national resources.

(2) That the Board be given an assured finance for five years; it is recommended that it should receive not less than £5,000 for the first year and £20,000 for each of the four following years.

(3) That the Board shall be representative of the various sections of science and industry.

(4) That the Board shall, as one of its chief functions, consider all proposals for specific scientific researches, and shall allot to the proper person or persons the duty of conducting such specific researches as it may approve.

(5) That in order to avoid centralisation, and in the interest of economy, the Board, in the carrying out of investigations, shall wherever possible co-operate with the University, College authorities in the various centres, with a view to making the fullest possible use of their staffs and laboratories; there shall also be set up local Advisory Boards to inquire into, advise, and report upon local problems.

(6) That one of the duties of the Board shall be to advise primary producers, and those engaged in industrial pursuits, as to the results of scientific investigations affecting or calculated to benefit their industries, including processes for the utilisation of waste products.

(7) That the Board shall have power to establish scholarships and also to award bonuses and prizes, with the object of encouraging scientific and industrial research.

(8) That the Board shall keep touch with Government Departments and also with scientific and educational institutions, with a view to co-operation in scientific investigation as well as in furtherance of scientific education and of everything which will tend to foster a greater appreciation of the advantages of science, not only by producers, but by the people at large.

INDUSTRIAL ART.

The attention of the Institute has been drawn by Mr. H. H. Smith, Principal of the Technical Art School, Ballarat, to the national importance of industrial art in the development of many of our industries. There are numerous industries which are almost entirely dependent upon design and creative art for their success and reputation, such as the textile industry, decorative pottery, and the manufacture of wall papers. It is the axiom of the trade that the pattern largely sells the cloth, and it is admitted on every hand that the development of certain Australian industries are hampered by the lack of skilled designers and craftsmen. Mr. Smith urges that a systematic development of industrial design, based on our natural flora and fauna, should in time develop a national type of design and an article peculiar to Australia, which would be recognised in other countries, and in time attain a reputation as world-wide as that now enjoyed by Lambeth, Sevres and Dresden pottery, Paisley shawls, or West of England tweeds. Before we can hope to develop an international style of art, a much more systematic and fully-organized study of industrial art is necessary.

ENGINEERING INDUSTRIES AND SCIENTIFIC RESEARCH.

The British Engineering Trades (New Industries Committee), in its report to the Minister of Reconstruction, strongly emphasises the great importance of scientific and industrial research in connexion with the establishment and development of new Engineering Industries. It is recommended that the National Physical Laboratory, which has done invaluable work during the war, should be greatly developed and equipped with substantial funds to enable it to undertake research on the largest possible scale. It is stated in the report that the work done by the National Physical Laboratory is insufficiently known to manufacturers, and the Committee feels that it is desirable that steps should be taken to draw the attention of all those who might benefit by its services to the assistance that it can afford.

SPECIALISATION AND STANDARDISATION IN ENGINEERING INDUSTRIES.

The same Committee states that it is clear that, in some branches of the Engineering trades, industry has not kept pace with up-to-date requirements. The principal remedies for this state of affairs are believed to be specialisation and standardisation. Specialisation leads directly to standardisation of the product, first because it is necessary to secure economy of manufacture, and, secondly, because a more extended experience with a restricted range of products brings out the best methods of construction and manufacture. By standardisation the Committee does not imply the slavish adherence to a fixed design to the detriment of the introduction of improvements or of entirely new designs. On the contrary, it is anticipated that the combined policy of specialisation and standardisation will mean rapid progress.

STANDARDISATION OF CHAINS.

One of the results of war-time collaboration in the national interests of British Chain Manufacturers is now seen in the formation of a permanent Association, the main objects of which are—

(1) The standardisation of chains, wheels, and chain wheel-cutters, so as to insure interchangeability and increase production.

(2) The carrying out of comprehensive research work. It is anticipated that the policy which the Association has thus adopted will enable British driving chain manufacturers to greatly extend and improve their businesses.

STANDARDISATION IN COACH BUILDING INDUSTRY.

At the recent Federal Conference of Coach, Waggon, and Motor Body Builders, held in Melbourne last September, attention was directed to the desirability of standardisation of materials and especially of wheel materials. Information was furnished to the Conference showing the extraordinary variety in sizes and types of spokes and naves used, especially in drays and waggons. Great interest was evinced in the question, and the Conference passed a resolution requesting the Institute of Science and Industry to convene a Conference of Coachbuilders and Manufacturers of Carriage and Waggon Materials to draw up a schedule of standard sizes and shapes for carriage materials.

The question of the utilisation of Australian timbers was also discussed by the Conference, and a second resolution was passed urging that research work on the physical properties of Australian economic timbers should be undertaken by the Institute on the lines adopted by the Forest Products Laboratory of the United States of America Department of Agriculture.

POWER-ALCOHOL—RESEARCH WORK IN ENGLAND.

At the request of the British Alcohol Motor-fuel Committee, Professor Harold B. Dixon, Department of Chemists, Manchester University, has undertaken the direction of a scheme of experimental work to

provide accurate data concerning the behaviour of power-alcohol, alcohol-benzole, alcohol-ether and other alcohol mixture vapours, in their combustion with different volumes of air, and with varying percentages of water and denaturants. Professor Dixon has pointed out that the supply of petrol will not last nearly so long as the supply of coal. Petroleum experts, he stated, all say that the supply will not last very many years, if the demand increases at what appears to be the present rate of consumption. If our coal supply will last 400 years, it is quite possible that the supply of petrol might only last 40 years. It is, therefore, necessary to look out for some substitute which will be more perennial and more permanent than the supplies of petrol, and amongst the possible substitutes alcohol is an obvious one. Referring to the aims of the Alcohol Motor-fuel Committee, Professor Dixon said they were out to discover whether alcohol could be made cheaply, whether by fermentation of grain of some sort, or of potatoes or fruits, or whether it could be made synthetically from ethylene, or from hydrocarbons to be extracted from coal gas or from coke-oven gas. If a new petrol substitute is found to be of practical utility, it would be used not only for motor cars, but for other internal combustion engines. There are certain physical properties of alcohol which have to be studied in order that engines which burn it can be rightly designed, and it is research on those physical properties that Professor Dixon has been asked to undertake for the Committee.

POWER-ALCOHOL—RAW MATERIALS.

In the report of the British Committee which is investigating the questions of the production and utilisation of alcohol for power and traction purposes, the information given regarding the various raw materials confirms the conclusions reached by the Special Committee of the Institute of Science and Industry. In its report the British Committee states that steps should be taken to insure increased production of power-alcohol by the extended use of the vegetable matters from which it may be obtained. Important materials of this nature are—

1. Sugar-containing products, such as molasses, mahua flowers, sugar-beet, and mangolds.
2. Starch or inulin-containing products, such as maize and other cereals, potatoes, and artichokes; and
3. Cellulose-containing products, such as peat, sulphite wood-pulp, lyes, and wood.

With a large scale cultivation of maize and other cereals as raw materials, the manufacture of power-alcohol has admitted possibilities, and the prospective production of alcohol from these sources in the overseas Dominions and other parts of the Empire is encouraging as regards quantities and cost. Some interesting information is given regarding the production costs and yields of power-alcohol from the flowers of the mahua tree (*Bassia latifolia*), which flourishes in the Central Provinces of India and in Hyderabad. The sun-dried flowers of this tree contain on the average 60 per cent. by weight of fermentable sugar. They can be collected and delivered to the factory in the zone of growth at a cost of £1 10s. per ton, and the yield is found to be about

90 gallons of alcohol (95 per cent.) per ton. As regards potatoes and artichokes, the Committee concludes that power-alcohol cannot be produced in Great Britain from these sources on a commercial basis, except under some system of subvention. Similar conclusions are reached also in regard to sugar beet and mangold crops. No satisfactory method for the utilisation of peat as an economic source of power alcohol has been brought under the notice of the Committee. The opinion is, however, expressed that in connexion with researches into the use of peat for various purposes, its potential value as raw material for the manufacture of alcohol should not be overlooked.

LUMINOUS PAINTS FOR LEVEL-CROSSING GATES.

A proposal has been made to the Institute that phosphorescent paints should be used for painting gates and posts at railway level-crossings, thus obviating the necessity for artificial lighting at such places.

Phosphorescent paints, consisting essentially of more or less pure sulphides of calcium, strontium, and barium, have been used since the eighteenth century. They are more efficient if the impurities consist of manganese, lead, bismuth, or uranium salts. They phosphoresce for a short time after having been exposed to a bright light, but they are of limited value. Recently auto-luminous paints have been made by mixing zinc-sulphide with a small amount (about 0.01 per cent.) of radium salts, and these, though necessarily expensive, have been largely used for illuminating watch dials, keyholes, electric switches, &c. The radium on a watch dial is stated to cost about 6d.

A recent development has been to replace the radium by mesothorium; the latter is present in thorianite and monazite, and is obtained as a by-product in the manufacture of gas mantles. The cheaper price of the mesothorium is, however, largely counterbalanced by its short, useful life. It may be considered that it will not develop its full activities for some months after it has been prepared, and that it will cease to be of much use after about five years. Of course, it is possible that by that time sufficient advance will have been made in our knowledge of luminous paints to justify the scrapping of all such mixtures as could be made to-day. Considerable use was made of these paints during the war. Luminous tapes were used to define paths, &c., leading to the front line trenches, and raiding parties would wear luminous patches on their tunics to assist their identification by one another in the dark.

KELP INVESTIGATIONS.

In connexion with the experimental work which has been going on in Tasmania in regard to the utilisation of bull-kelp, Mr. V. G. Anderson, Melbourne, has specially interested himself in this matter, and has collated a great deal of information regarding developments in other countries, especially in the United States of America. Mr. Anderson has kindly consented to prepare a report on the whole question for publication as one of the Institute's bulletins.

WHITE ANT PEST.

Co-operative arrangements have now been completed between the Institute and the New South Wales Department of Agriculture for carrying out investigational work in connexion with the white ant pest. A Special Committee has been established for the purpose of controlling the work. The *personnel* of the Committee is as follows:—

Mr. A. A Ramsay, Agricultural Chemist's Department, Sydney, and Dr. G. P. Darnell-Smith, Department of Agriculture, Sydney, representing the New South Wales Department of Agriculture.

Mr. G. F. Hill, Entomologist, Institute of Tropical Medicine, Townsville; Mr. L. Harrison, B.A., B.Sc., Lecturer on Biology, Sydney University; and Mr. E. E. Turner, B.A., B.Sc., Lecturer on Organic Chemistry, Sydney University, representing the Institute of Science and Industry.

It may be remarked that Mr. G. F. Hill has already carried out a large amount of investigational work on termites, both in the Northern Territory and at Townsville, and he has concluded that local conditions in Darwin would be more favorable for the study of these insects than in Townsville. Mr. Hill is now compiling the results of his investigations during his four years' stay in the Northern Territory, and they will be published as one of the Institute's bulletins.

ALUNITE.

It is reported that a very extensive deposit of alunite has been discovered on the West Coast of Vancouver Island, B.C. At the request of the persons interested in this deposit, the Institute has furnished full information regarding the results of the research work carried out in Australia. The authorities in British Columbia are of the opinion that the experimental work carried out by the Institute will be of considerable value in facilitating the development of their deposits.

FLUE DUST FROM FURNACES.

The Institute has been requested to advise as to the value for fertilising purposes of the flue dust from the Richmond Electric Light and Power Station. Analyses of the dust were made, and disclose the fact that the material is of no value as a source of potash or as an agricultural fertiliser, except for some slight mechanical effect it may have on certain soils. The dust contained only 0.05 per cent. of potassium oxide and 0.3 per cent. of phosphoric anhydride.

THE FLAX INDUSTRY.

The Commonwealth Flax Industry Committee, which was established by the Government on the recommendation of the Institute, as a result of the Conference of Agricultural Scientists convened in 1917, has recommended the Government to continue the guarantee for raw-flax. It is understood that the Government does not intend to let this industry languish. Already the acreage under crop has been increased from 500 to 2,200 acres, and the Flax Committee anticipates that no less than

5,000 acres will be planted during next season. The development of this industry is directly due to the work of the Institute of Science and Industry, and the increase in wealth already produced would pay several times over for the total cost of the Institute.

BAGASSE AS A RAW MATERIAL FOR PAPER PULP.

The possibilities of utilising bagasse, which is the waste material from sugar mills, was investigated in England by Thomas Routledge as far back as 1856. Previous to that time linen and cotton rags were about the only known material for book and writing papers. Mr. Routledge's experiments were carried on in an open vomiting boiler by cooking with caustic soda, and he was successful in producing high grade papers from the material. On account of the facility of collecting esparto grass by cheap labour in Morocco, it was decided to utilise esparto in the manufacture of high grade book-printing papers which could have been produced from bagasse if the commercial conditions had been more favorable. Esparto has recently become much more expensive, owing mainly to increased labour costs in collection, and the time may not be far distant when, by proper preliminary treatment, bagasse fibre may supplant esparto and become commercially practicable in locations where the conditions are favorable.

From time to time various experiments with bagasse have been carried out in the United States of America. A number of patents have been issued for methods of treatment, but they are of doubtful value, since bagasse can be treated by the ordinary methods such as are used in the manufacture of esparto papers. The whole question appears to hinge on the conditions of the sugar industry. Sugar mills generally produce large quantities of bagasse for a few months of the year, while for the balance of the year they are shut down. Bagasse deteriorates rapidly when stored in air, and it would not be practicable to establish a pulping plant except for practically continuous operation throughout the year. From the sugar miller's stand-point, it is evident that he must sell his bagasse at a price high enough to replace it with other fuel to advantage.

The problem of supplying bagasse to a continuously operating pulping plant from an intermittently operating sugar mill involves treating the bagasse at the sugar mill in such a manner that it can be stored without deterioration during the period sugar mills are idle. This is the most important problem in the bagasse situation, and it must be satisfactorily solved before bagasse can be used commercially in a pulp-manufacturing plant. Experiments on this problem have recently been carried out in England by Messrs. Joseph H. Wallace and Company, and it is stated that the results are, so far, promising.

IMPERIAL ENTOMOLOGICAL CONFERENCE.

The Commonwealth Government have received from the Colonial Office a letter stating that an Imperial Entomological Conference is to

be held in London in 1920. It is considered that such a Conference would serve a number of useful purposes, of which the two most important are—

(*a*) It would be valuable as bringing together the official entomologists, who would discuss problems of Imperial importance in the prevention of the spread of insect-borne diseases; and

(*b*) It would afford an opportunity of placing the entomologists in closer touch with the Imperial Bureau of Entomology and of settling lines on which that Bureau can render further assistance to the different parts of the Empire.

In many of the problems in which the Institute is concerned, entomological work is of the first importance. The Institute, therefore, approves of the proposal to hold the Imperial Conference, and thinks it desirable that the Commonwealth should be represented. As neither the Commonwealth Government nor the Institute has an official entomologist, and, with a view to save expense, the Institute has recommended that advantage should be taken of the presence of Professor R. D. Watt, M.A., B.Sc., Sydney University, in London next year to officially represent the Commonwealth at the Conference.

INDIGENOUS GRASSES AND FODDER PLANTS.

The Institute has received a report on the above matter from the Standing Committee which was established as the result of the Inter-State Conference of Agricultural Scientists convened in Melbourne by the Institute in November, 1917. The purpose for which the Committee was appointed was to deal with the collection, propagation, improvement, and cultivation in suitable areas of indigenous grasses and fodder plants.

Mr. G. L. Sutton, representative of the Committee in Western Australia and the Commissioner for the wheat belt in that State, has found that Sudan grass in Western Australia has produced better results than the native grasses. This was also the case in New South Wales last summer, but it must be remembered that the drought conditions were phenomenal, so that the results from last season are inconclusive. Moreover, Sudan grass must be treated as an annual. It should, however, occupy a useful place in the semi-arid districts of Australia. The demand for seed of this grass for the interior of New South Wales has been remarkable.

Thorough investigations into the germination and growth of native grasses were carried out by Mr. W. J. Spafford, the Committee's representative in South Australia. The results achieved in regard to the ready germination and persistent growth of Wallaby grass (*Danthonia semi-annularis*) should help to extend the reputation which this grass has already obtained in New South Wales. Plots of this grass are being extended in New South Wales with very little difficulty, and as many sheep-breeders consider it the best "all the year round grass" we possess, this development is a matter of considerable importance. As in South Australia, Australian millet (*Panicum*

decompositum) has been found to germinate very easily in New South Wales. The small growth in the former State was probably due to the lateness of the season. In New South Wales it grew about 2 feet high during the past season, which was one of the driest on record. Its succulence is a very desirable feature.

The germination of Coolah grass (*Panicum prolutum*) was fair in South Australia and Western Australia. During the drought in New South Wales this grass was cut at Hawkesbury Agricultural College three times at over 3 feet high on a rainfall of about 5 inches, while in other parts of the New South Wales coastal districts farmers reported on it very favorably.

Queensland bluegrass (*Andropogon sericeus*) proved in New South Wales to be very susceptible to drought, and was inferior to Satin Top grass (*Andropogon erianthoides*). In this respect there are some strains of Queensland bluegrass superior to the native strain, and these are being propagated at Cowra Experiment Farm. Other grasses which have shown out well in New South Wales during the past drought are:—Elephant grass (*Pennisetum purpureum*); Rhodes grass (*Chloris gayana*); Hooker's Fescue (*Schedonorus hookerianus*). A considerable number of other grasses is being tested by the Committee.

COTTON GROWING.

In connexion with the experimental work which is being carried out by the Institute on the subject of cotton-growing, the opinion of experts, both in Australia and abroad, is that the proper way to develop the cotton industry on a secure basis in this country is by experimentation, as has been done in the case of wheat-growing, so as to ascertain the varieties of cotton best suited to climatic and other conditions in various parts of Australia. The Institute has accordingly obtained, for experimental purposes, from the Bureau of Plant Industry, Washington, United States of America, small parcels of a number of leading varieties of cotton seed, including especially long stapled varieties and the varieties cultivated during recent years in Arizona and California. The climatic conditions in these two States approximate more closely than other parts of the United States of America to conditions in Queensland. This cotton seed will be cultivated experimentally under proper control. Special steps have been taken for the treatment of the seed, without impairing its vitality, so as to avoid risk of introducing with the seed any disease attacking the cotton plant.

One of the drawbacks to the development of the cotton industry on an extensive scale in Australia has been the high cost of labour as compared with other countries. There are various indications that the cost of labour both in the United States of America and Egypt is likely to increase. We are told that recently 30,000 negroes have given up cotton farm work and have accepted engagements in Chicago. There is a general movement, also, among factory and other workers in the southern States of America for higher rates of pay and shorter hours.

COTTON RESEARCH ASSOCIATION.

Under the scheme promulgated by the British Department of Science and Industry, a Cotton Industry Research Association has been established. The attention of this Association will be directed to the development of cotton-growing within the Empire, to all that relates to the chemical side of the industry, and to manufacture. The comprehensive objects can be best described in the official terms of the Association, viz.:—

> "To promote research and other scientific work in connexion with the production of cotton and its utilization in industry, and, generally, in connexion with any branch of trade or commerce producing, using, and handling cotton, whether in a raw or manufactured state, or producing machinery, accessories, substances, or appliances to be employed in the production of cotton or its utilization in industry, and to provide and spend money as may be thought necessary or convenient for these purposes, and to encourage and improve the education of persons who are engaged, or are likely to be engaged, in the industry."

The Department of Scientific and Industrial Research has agreed to contribute £5,000 per annum for five years on the condition that the Association raises a similar sum. If more is contributed by the Association, an equal amount will be added by the Government. The Federation of Cotton Spinners and Manufacturers' Association, the Employers' Federation of Dyers and Finishers, and the Federation of Calico Printers are actively co-operating in the work. Applications have recently been invited for appointment to the position of Director of British Cotton Industry Research Association, at a salary of not less than £1,250 per annum.

COTTON INDUSTRY IN SOUTH AFRICA.

Since the establishment of the Union, the cotton industry in South Africa has made considerable progress. The latest available figures show that over 7,000 acres are under cultivation, mainly in the Rustenburg and Waterberg districts. The yield of seed cotton has increased from 41,000 lbs. in 1910-11 to 700,000 lbs. in 1916-17. During the same period the yield of lint has increased from 13,000 lbs. to 233,000 lbs. Later results are not quite so good, owing to the damage by the boll-worm and by frost; had conditions been favorable, the yield of cotton, according to the estimate of the Rustenburg Farmers' Co-operative Union, would have been between three and five million pounds of cotton.

It is felt, however, that, in spite of the growth of the cotton industry, the methods adopted in treating the cotton seed do not enable the growers to realise the fullest possible value of their product. The Rustenburg Farmers' Co-operative Union applied some time ago to the Industries Advisory Board for financial asistance in the proposed erection of an oil-expressing plant. A Committee of the Advisory Board visited Rustenburg in December, 1917, to investigate. The Co-operative Union proposed that the oil press should be erected by the Government, and controlled by the Union on the pound for pound principle.

After investigation the Industries Advisory Board made the following recommendation to the Government:—

> "That, after due consideration of the subject, this Board desires to recommend that the financial assistance asked for in respect of the erection and equipment of an oil-expressing mill, at Rustenburg, be granted by the Government to a combination of cotton-growers, membership in which shall be given to the growers of cotton throughout the Transvaal province, and this for the purpose of aiding the development of an important industry. The Board is further of opinion that some proportion of the funds required for the purpose should be raised by the members of the said combination of cotton-growers, or that satisfactory security for the repayment of the loan should be furnished."

The matter is now under consideration by the Government, and a decision will probably shortly be made.

REVISED CLASSIFICATION OF IMPORTS.

In connexion with the work which is being undertaken by the Institute with a view to bringing about a more satisfactory grouping and adequate sub-division of statistics of imports, the Chamber of Manufactures has now nominated members of the Committees which are to carry out the work, and which will consist in each case of a manufacturer, an importer, and a statistical and Tariff expert. The following have been appointed members of the respective Committees on the nomination of the Chamber of Manufactures:—

1. Foodstuffs of Animal and Vegetable Origin.—Mr. Guy Smith, Hoadleys Pty., Melbourne.
2. Vegetable Substances, &c.—Mr. T. Hogg, Jas. Miller & Co., Melbourne.
3. Apparel, Textiles, &c.—Mr. R. A. Pryor, Acme Shirt Factory, Melbourne.
4. Oils, Fats, &c.—Mr. F. W. Kitchen, J. Kitchen & Sons, Melbourne.
5. Machines and Machinery, &c.—Mr. E. P. Lewis, Kelly & Lewis, Melbourne.
6. Indiarubber.—Mr. F. S. Ormiston, Barnet Glass Rubber Co., Footscray.
7. Leather, &c.—Mr. A. O. Vary, North Melbourne.
8. Wood and Wicker, &c.—Mr. R. R. Grundy, Grundy & Co., Brunswick.
9. Earthenware, Cements, &c.—Mr. J. S. Walker, Royal Park.
10. Paper.—Mr. A. R. Stewart, McCarron, Bird, & Co., Melbourne.
11. Stationery.—Mr. A. R. Stewart, McCarron, Bird, & Co., Melbourne.
12. Jewellery, &c.—Mr. J. Larard, Larard Bros., Melbourne.
13. Optical Instruments, &c.—Mr. Russell Grimwade, Felton, Grimwade & Co., Melbourne.

SHEEP-FLY PARASITES.

In connexion with the reported discovery by Professor Lefroy, in England, of certain new species of parasites which destroy sheep blowflies and their pupæ, the Institute has made inquiries into the matter, and has received a cablegram from the High Commissioner's Office, London, stating that Professor Lefroy believes it will be possible to reproduce in Australia natural control of the sheep-fly pest similar to that obtaining in Great Britain. Professor Lefroy has four separate sheep-fly parasites under observation, and the indications are that at least one is very satisfactory. Three of the parasites are stated to be innocuous, excepting in regard to sheep flies, but, as regards the fourth, experiments under control are necessary. Further experiments are being carried out in England, and it is intended, if the results are satisfactory, to obtain sufficient specimens for experiment in Australia towards the end of the year. The Institute has made a grant of £100 for these purposes, and Dr. Gilruth is keeping in touch with the work whilst he is in England.

CONTAGIOUS ABORTION IN CATTLE.

For some time past a considerable amount of valuable investigational work has been carried out by Professor H. A. Woodruff and Mr. H. R Seddon, of the School of Veterinary Science, Melbourne, on the subject of contagious abortion in cattle—a disease which causes an estimated loss of from £250,000 to £500,000 annually in Victoria alone. The investigations were stopped, as Mr. Seddon enlisted, and has not yet returned to Australia. He is now undergoing a special course of training in England, with a view to continuing the investigations on his return to Australia. The valuable results which have been obtained from these investigations have been due partly to the special facilities which exist for the work in Victoria. There is contagious abortion among a herd on one of the Victorian Department of Agriculture's farms, which carries about 120 head of stock. That herd has been in existence for ten or eleven years, and an accurate record has been kept of every service, every calving, and every abortion. The whole history of the herd is, therefore, on record. A similar opportunity has probably not occurred to investigators in other countries. The Institute has made a grant of £150, in order to enable Professor Woodruff to employ a research scholar to carry out investigations on two lines of work which will be complementary to the continuation of the larger investigations which are contemplated. The objects of the work, which is to be started at once, are:—

1. To discover a method of raising the virulence of the contagious abortion bacillus, so that its immunizing power may be similarly raised.
2. To determine the effect of "sensitized" living cultures to discover—
   - (*a*) Whether they will infect and so produce carriers; or
   - (*b*) Whether they will set up an immunity without infecting, and so avoid the carrier risk.

DISEASES AFFECTING PRIMARY PRODUCTION.

As a result of a discussion at the last meeting of the Executive Council of the Primary Producers' Union, Sydney, the Institute has been asked to concentrate specially upon scientific research work in regard to all diseases that affect primary production. The Primary Producers' Union points out that problems requiring immediate attention are contagious abortion, black-leg, and itch in horses; and in connexion with plant life, rust and other fungus diseases in wheat, and the eradication of noxious weeds—particularly St. John's Wort. It is hoped that when the Bill to establish the permanent Institute is passed, the work which is now being done in regard to these matters will be actively developed.

WOOL RESEARCH.

In a farewell address to members of the Australian Imperial Force who have been taking an intensive course of study in wool at the Bradford Technical College, Mr. A. E. Lightowler, Deputy Chairman of the Technical College Committee, drew attention to the fact that a Wool Research Association has been established in England by the British Department of Science and Industry. He hoped that before long a branch of this Association would be established in Australia in conjunction with the Institute of Science and Industry.

A Glass Research Association is being formed in England under the ægis of the Department of Scientific and Industrial Research. The scheme provides that the glass manufacturers will contribute £25,000 over a period of five years on the condition that the Department finds a sum of £75,000 over the same period.

The need for science graduates is not disputed; the demand is another matter, and it is unfair to attract students by numerous scholarships to pass through a University or College course and then to leave them stranded, or with an entirely inadequate reward, at the end. Before increasing scholarships and increasing the competition for a bare livelihood in what, in pre-war days, was an overcrowded profession, it is first necessary to educate the industrial world; to open a reasonable number of posts in the technical departments of the Government to men who have specialized in science, and to improve out of all recognition the position of technical teachers. Once the public realizes that first-class opportunities are provided by a scientific career there will be no lack of candidates.

—***Science Progress.***

The Value of Irrigation.

The Murrumbidgee Scheme.

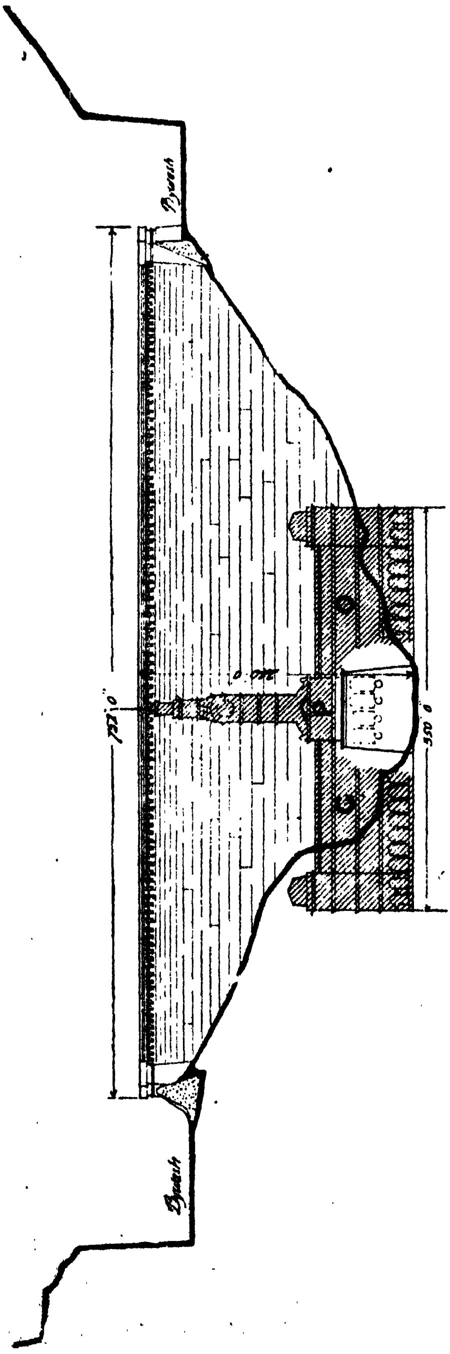
By E. N. ROBINSON.

No. 1.

Australia has not yet risen to a full appreciation of the value of irrigation. Three or four of the smaller settlements along the Murray have recently attracted more than passing attention, and the results which have followed their development would, without doubt, have hastened settlement had the water been available to justify a further large extension of the acreage in these localities. Until extra provision is made for storage at the head of this important waterway, there can be no appreciable increase of the irrigable area along the Murray. As the scheme which has been decided upon by New South Wales, Victoria, and South Australia, and which is being financially backed by the Commonwealth, proceeds, more and more land will be available, and it will be eagerly snapped up.

The keen demand for Murray River blocks, however, does not prove a general recognition of the economic importance and advantages of irrigation farming. It simply arises from the fact that the settlers at Mildura, at Renmark, and other places have prospered exceedingly during the last decade, and that the story of their success, often widely exaggerated, has encouraged the belief that to plant 10 acres of vines and a few orange trees is the surest way to get rich quickly. Apart from these outstanding illustrations to the contrary, irrigation enterprises have not given birth to that rich and stable settlement which was so confidently anticipated. Many factors have contributed to their retardment. Engineering mistakes, due to a lack of knowledge of soil condition, have been probably the most prolific source of failure. The selection of relatively unsuitable areas, and the endeavour to adapt them to inappropriate purposes, occasioned other serious setbacks. The delusion, that still to a large extent prevails, that the application of an almost unlimited quantity of water to a small area of land is the surest way to achieve good results, has frequently brought about the ruin of many a hard-working settler. In short, failure has sprung from indifferent scientific knowledge on the part of those who designed some of our earlier schemes, accelerated and completed by an insufficient scientific knowledge on the part of those who settled thereon. These mistakes, however, belong to the past. The serious defects have, to a large extent, been remedied, and a fresh start has been made. Australia has had to buy her experience, and in this respect she is by no means singular. The United States has made many more serious and more costly mistakes than we have done, and it were well to keep this fact in mind, rather than to brood over melancholy recollections. We can profit from our sad experience, as the United States has done from hers, and patiently look forward to the realization of those dreams of prosperous settlement which our initial grandiose undertakings inspired.

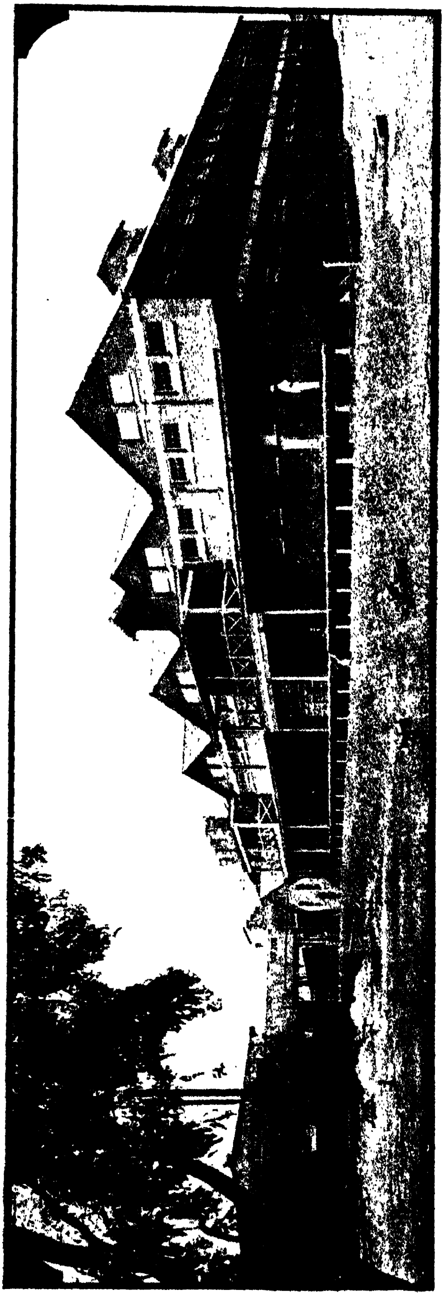
The Yanco irrigation scheme promises a fulfilment of these long-cherished hopes. It possesses all the broad, natural features essential to successful development. The human factor will be the determining quantity. There may probably be much to learn about the treatment of the land, but the soil, from a fertility consideration, is good; the water supply is unexcelled, and the climate is ideal. Bitter critics of the undertaking, however, are not lacking. Their name is legion. Condemnation is based upon the non-success of some of the original settlers. Without entering into the merits or demerits of the agitation which resulted in an enormous sum being paid as compensation, the fact remains that contiguous and similar land which disappointed men have abandoned is now being profitably cultivated. The purpose of this article is to outline the nature of the project, and not to discuss in detail difficulties which are inseparable from any big land settlement proposition, whether irrigation or dry-farming.



Comparison of length and height Barren Jack Dam Wall and G.P.O. Sydney

From an engineering point of view, Yanco is the fourth largest undertaking in the world. A number of familiar comparisons are often made illustrating the enormous storage capacity of the dam. When finally completed its water content will be larger than that of Sydney Harbour. The main retaining wall will have a maximum height of 240 feet, with a base 160 feet thick, tapering to 18 feet at

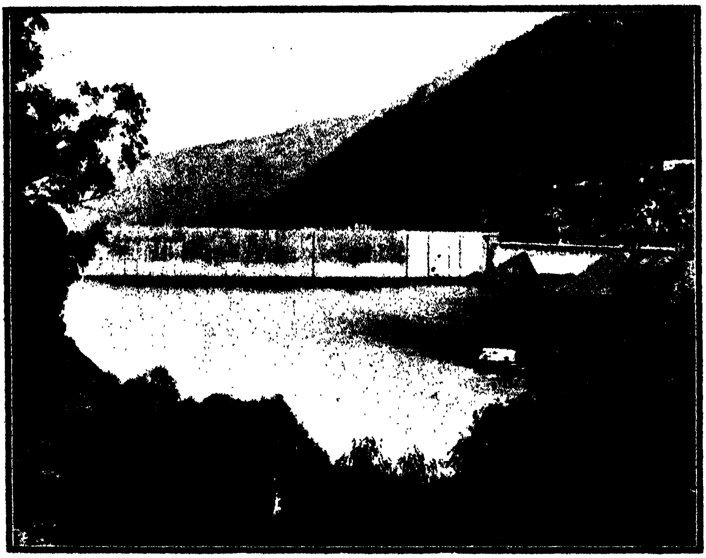
the top. The waters of the Murrumbidgee will be thrown back to form a lake stretching in one direction 41 miles, in another 15 miles, and in a third 25 miles. The construction is well in advance of settlement requirements. Burrinjuck, the point at which the dam is constructed, is a long distance from the irrigation areas. From the dam itself the water flows down the Murrumbidgee for 220 miles, where at a point named Berrembed, a weir has been constructed, which diverts the flow into the main canal. At the present time that canal is excavated nearly to the township of Griffith, 90 miles further on, and it will eventually extend another 30 miles. Since the closing of the outlet tunnel through the dam in 1913, the flow of the Murrumbidgee has been regulated at the dam. Sufficient water has been passed through the sluices to provide, with the unregulated discharge of the Tumut River and other affluent streams, a flow in the Murrumbidgee River sufficient to provide for irrigation requirements, and for the riparian interests. This is the principle which will be followed when the dam has been completed and the whole of the irrigation areas are in full operation. It is then estimated that the combined flow, partially regulated as above, will be sufficient to provide at Berrembed a continuous supply of 2,000 cubic feet per second, delivered into the main canal during the summer months, with a somewhat less quantity during the earlier and later months of the irrigating season, which usually extends from the beginning of September



CANNING FACTORY, LEETON.

to the end of April. From investigations systematically carried out since 1910 it has been estimated even if all the suspended silt in the stored waters was deposited, that it would take, approximately, 2,000 years for the dam to silt up. It is a reasonable conclusion, therefore, that the period at which the silt problem will become acute is very remote.

The visitor to the irrigation area sees nothing of the giant task that has been performed for the reclamation of the arid plains. His first intimation of his near approach to Yanco is a glimpse of the broad flowing yellow stream imprisoned between the red banks of the canal. One or two small patches of rich green vegetation, in striking contrast to the parched and desolate waste unserved by water, mark the frontier of irrigation activities. Then the train crawls alongside the Yanco platform, from which are visible a few small orchards, and a very limited acreage of lucerne fields. The introduction to the



PORTION OF THE DAM.

settlement is disappointing. First unfavorable impressions, however, are quickly dispelled. Four or five miles in a motor brings one to Leeton, the centre of operations of the eastern portion of the settlement, and the drive provides abundant evidence of the suitability of the soil for diversified and intensive agriculture. The fact is that that stretch of the railway line from Junee to Hay, which the Yanco Siding serves, merely skirts the edge of a very small portion of the territory embraced by the irrigation scheme, and does not traverse much of the country where settlement has taken place. It was around Leeton that the first blocks were made available six or seven years ago, and consequently this locality furnishes, at this stage of development, the best proof of the fertility of the land. A vastly different conception of the potentialities of the scheme would exist in the public mind if the railways cut through the centre of production and the results of irrigation farming were clearly revealed.

THE VALUE OF IRRIGATION.

Arrived at Leeton, however, one has not yet reached his destination. This township is merely the starting point, if the whole of the surrounding settlement is to be seen, of a number of daily journeys. When these are concluded another journey of between 30 and 40 miles, north-west from Leeton, must be made to Griffith, or one of the other centres of settlement on the Mirrool area, and more time must be spent upon daily peregrinations through this reservation before anything like a general knowledge of the scheme and its possibilities is obtained. What is variously known as the Murrumbidgee scheme, the Burrinjuck scheme, or the Yanco scheme consists, therefore, of two separate and remote areas—Yanco and Mirrool—comprising between them 200,000 acres of land for which water is either now available or is being made available. The Mirrool area also enjoys railway communication, being fed by a spur line which branches off the Cootamundra-Wyalong service at Temora. It is proposed at an early date

A SETTLER'S HOME.

to link up these two main subdivisions by means of a railway, either electric or steam, and so provide for the transference of produce to the various factories specially equipped for its treatment, as well as to afford social interchange between the settlers. A great deal of the intervening country is controlled by the Commission, and within it lies a huge dry lake which is being utilized as a run-off for the drainage waters after irrigation. Some of the unirrigated country is also being rented to the irrigation settlers, whilst other portions are rented to graziers. The country is typical of a great deal of the Riverina, possessing very little big timber, and some of it is covered by mallee scrub. The soil varies somewhat in its physical and chemical aspects, but is of uniformly high fertility. Its one main deficiency is phosphorus, and in this respect it resembles practically the whole of what are commonly termed the wheat lands of Australia—the red basaltic

formation occurring so largely in New South Wales, Victoria, South Australia, and West Australia, which produces nearly all of our wheat. A substratum of clay occurs at varying depths through some of the land, and it is this fact which gave rise in the early days of settlement to a fierce controversy as to the wisdom of the choice of the locality. Fortunately, however, the criticism which was evoked has not prejudiced the success of the undertaking. The scheme itself is sound, as industry and intelligence are demonstrating to-day, and will exemplify in a much more striking manner a few years hence. It is possible that cultural problems may occur here, as they have occurred in every part of the world where irrigation has been practised, but up to the present, confining comparison to Australia, the Yanco settlers have been singularly free from difficulties.

MAIN STREET, LEETON.

To return to Leeton. The township and the surrounding country has already a population of between 4,000 and 5,000 people, where, prior to the advent of irrigation, there were only a few families. Leeton itself is lighted by electricity, and the settlers for 5 or 6 miles out use electricity in their homes and on their farms. Any one who has been privileged to visit some of the old-established irrigation settlements of California, who has seen the beauty and splendour of the avenues and of the private gardens, and the wealth and the high

standard of living of the irrigationists will find no counterpart of these things on the Yanco settlement. The medium through which they may be obtained, however, is there. Nothing which the Californian settlers originally possessed is lacking to the man who takes up land at Yanco. Therefore, with a knowledge of what has been achieved in other parts of the world, it requires little imagination to visualize the conditions which should obtain in the not far-distant future. At the present time, however, it is a matter of hard work and self-establishment. Orchards must be brought to maturity, dairying herds must be bred, and field crops must be grown. Incidentally the practice of irrigation must be learned. The mechanical effect upon the soil of the application of water and of the various cultural operations must be appreciated. There are one hundred and one little difficulties to be faced and problems to be solved before the community can devote time to the beautification and transformation of the public roads, the recreation grounds, and the township. Irrigation, and all the desirable social and economic advances it connotes, must, therefore, not be judged by the Leeton of to-day. But even in its raw state, what a contrast this area presents to most of our inland country. In the first place, there is fairly compact settlement. Blocks of from 20 to 50 acres mean homes almost within a stone-throw of one another, and isolation disappears. Furthermore, schools are within easy reach of the children, and public halls and reading rooms are accessible to all. Postal and trade conveniences are much the same as those of a suburb of a large city. In the summer months, the face of the country, instead of being parched and burnt up, is mantled with green. There is an ample supply of water for domestic uses, and there is an abundance of fruit, vegetables, and milk. Visitors making their first acquaintance with the Yanco area have inquired, as they have viewed from the township the numerous homes dotting the landscape, "What do all these people do for a living?" It does not at first occur to them that these small holdings can be made in the course of a few years to yield larger returns to the owners than areas forty or fifty times their size produce when left to take their chance with nature.

Already many of the longer established settlers are beginning to earn the reward of their early struggles. Some of the individual returns obtained indicate what the land is capable of. Gross average returns per cow have reached as high as £2 per month, and many others have ranged from £1 10s. to £1 17s. per month. The growth of the dairy industry is revealed by the operations of the butter factory. In the year ended June, 1916, 175,487 lbs. of butter were made. In 1917 the output was 310,186 lbs., and in 1918, 449,938 lbs. For the last half-year the output was 285,568 lbs. Similarly the bacon factory shows a progressive record, and in two years the number of pigs slaughtered jumped from 558, in 1916, to 7,194, in 1918. It is estimated that the yield of deciduous fruit this year will reach 2,500 tons, while the citrus returns for the present season amounted to about 10,000 cases.

(To be continued.)

The Debt to Science.

By **LORD MOULTON.**

IF, with regard to the war, we ask ourselves "What does it owe to science?" one is tempted to reply that in the first place it owes its very possibility to it. But for the stupendous advances that science had made in times within the memory of many, no catastrophe at once so wide-spreading and so deep-reaching could have happened. In scale and intensity alike, this war represents the results of accumulated scientific progress —it is the realization of all that which the accumulated powers with which science has endowed mankind can effect when used for destruction. We must be on our guard against treating the word science in such a connexion as though it included only the more recent advances that science has made. Her old and her new gifts have alike been put under contribution. The development of the human race has been the result of its increase of knowledge of the world around us, of the properties of the substances that it contains, and the laws that govern them. Each such increase of knowledge has brought with it an increase of power. Man learns more fully the resources of the world in which he lives, and what assistance he can procure for himself therefrom when he seeks to effect something which is beyond his unaided powers. Thus, step by step, he has increased his capacities to an almost limitless extent. Gifted with only mediocre vision, the telescope enables him to see the almost immeasurably distant, and the microscope to see the almost immeasurably small. In spite of his little strength, he can shatter in pieces the hardest rocks, and lift the most stupendous weights. If we would learn to what he can attain in speed, we must look to his skates, his cycles, his motors, and his aeroplanes. The whole world is not too big for his powers for communicating instantaneously with his fellow man, either by sign or speech. In short, although there is little ground for thinking that a man comes into the world endowed in any wise differently from his ancestors of many thousand years ago, the accumulated gifts of science have opened out to the adult civilized mind of to-day the possibility of a life which covers a realm, and which is endowed with powers wholly transcending those for which nature framed him as an individual.

It is to men thus endowed that this war has come with all its overpowering motives and wild stimulus, and to its service they have devoted all these acquired powers. To understand, therefore, what part science has played in the war, we must not only look at the specific new discoveries that have been made in connexion with it, but we must have regard also to the advances which had already begun to play their part in peace, and which under the stress of war had been pressed into its service. Indeed, we shall find that these have played at least an equal part among the great formative influences which made this war what it has been.

That which has rendered the burden of the war so crushing has been the huge scale on which it has been waged, and this has been the direct consequence to the extent to which the machinery of peace has been utilized in it. Man mastered transport, aviation, telegraphy, and the like in order to add to the conveniences of peace; it was a result, though not a motive, that he thereby revolutionized war.

There is one further consideration to be borne in mind if we rightly appreciate the relation of science to war, as evidenced by the fateful years through which we have just passed. All our advances in knowledge and power of which I have spoken concerned intellect only, and not character, and we are learning to our cost that no development of intellect necessarily brought with it moral growth. No better proof could have been vouchsafed to us than our recent experience.

Half a Century's Progress.

The history of the last half-century furnishes us with excellent material for appreciating the part which science has played in this war. Forty-four years elapsed between the outbreak of the first Franco-German war and that of the one that is just concluding. The circumstances of the two were strikingly alike. In both we find Germany choosing her own moment for making a deliberate and long-planned attack on France. In both cases she had accumulated a vast army furnished with abundant provision of every munitions prescribed by the military science of the time. In theory, if not in fact, France was similarly equipped. The tactics of the attacking party were the same in both wars, and the immediate result in each case was a successful invasion of France. Fortunately the parallel goes no further. But the duration of each was sufficient to show the features of a war waged with the knowledge and appliances of the time, and thus the earlier war furnishes a datum line from which we can measure the changes that have had their origin in the scientific progress that has been made in the intermediate period.

Smokeless Powder.

The novel features introduced into war now are so many and so varied that, either in form or in substances, well-nigh everything has been changed. In 1870, neither barbed wire existed nor its remedy, the Tanks. The guns then used were mainly field guns, though they were associated with a few early attempts at rapid firing by means of mechanical guns, such as the French mitrailleuse. In the late war, however, we find, on the one hand, both armies using in the field large numbers of guns of heavy calibre, firing at long ranges; and, on the other hand, a new war of position, with its special armament of machine-guns, trench mortars, Stokes guns, and hand grenades constituting a system of almost continuous hand-to-hand fighting. The old mechanically-fired quick-firing guns have been superseded by automatic machine-guns, which load and fire themselves by the spent energy of the preceding discharge, and being no longer dependent on human manipulation, can fire at any desired rate up to, say, ten shots a second. Aeroplanes report by wireless telegraphy particulars of the movement of the enemy and the location of his guns, and thus almost destroy the element of surprise

that was once the main object of strategy. Where sight fails to locate his batteries, sound is made to do its work. Bombing by airships and aeroplanes forms a new branch of tactics, as does also the offensive by gas attacks, and the corresponding defensive by gas masks. Add to these the use of submarines and the power of instantaneous communication with each unit of a fleet wherever located, by means of wireless telegraphy, and we realize that it was no empty phrase to say that we had thus entered into a new era.

Science of Explosives.

Take the subject of explosives, the basis of all modern warfare. The science of explosives is merely a study of the phenomena of combustion. An explosive is nothing other than a combustible substance that can burn rapidly without needing to be in communication with the external air. This may sound a very gentle definition of so terrifying a thing as an explosive, the very name of which suggests the possession of enormous force, under uncertain control. People are prepared to credit such a substance with secret stores of power wholly surpassing those that are possessed by other bodies. This is, however, far from being the case. It may surprise many, yet it is true. It may safely be said that there will never be an explosive which can give out nearly as much energy as an equal weight of coal or petroleum. Nitro-glycerine stands first of our most violent explosives, and yet the power it can generate is less than one-sixth of that given by the combustion of an equal weight of good coal. The difference in the effects in the two cases is due to the fact that the coal needs the oxygen of the air for its combustion. In nitro-glycerine the oxygen is to be found in the explosive itself. The explosive can therefore burn with rapidity, and within closed walls, and the hot gases thus generated, which are many hundred, or even thousand, times the volume of the explosive itself, gives the sudden pressure which bursts the containing walls, or, in a gun, drives out the projectile. The history of explosives was the history of the means of laying up this oxygen close by the side of the combustible. It was first accomplished in the invention of gunpowder. Here the combustible was a mixture of charcoal and sulphur, and the oxygen was contained in saltpetre, which is the best known member of a class of bodies that contain large quantities of oxygen, which is readily given off when they are heated to a high temperature in the presence of combustible matter. Gunpowder is a remarkable instance of successful invention. Whether it was Roger Bacon, or some unknown Chinese forerunner, who first devised it may be doubtful, but the ingredients were rightly chosen from the first, and the proportions have practically remained the same from early in the Fourteenth Century to the present day. It can boast of having satisfied all military requirements for five and a half centuries, and is even now very far from being superseded at the present day.

Excellence in the explosive was attained in the case of gunpowder by grinding the materials to fine powder and thoroughly incorporating them. Thus each particle of combustible had its necessary oxygen close at hand, and when the combustion was started at some one point by a spark, it rushed through the mass with a speed sufficient to cause the explosion. Some 80 years ago, chemists discovered substances in which

the combustible and the oxygen are present in one and the same molecule. Like the lion and the lamb of which the prophet speaks, they lie down together, and it is not until the molecule is shattered by heat or shock or some other like agency that they rush together into combustion. As might be expected, such a combustion is instantaneous, and the explosion it produced is very violent, far exceeding all that had previously been known. These bodies were the earliest forms of what are now known as high explosives.

A Great Discovery.

Such a discovery was sure to be seized upon for the use of war, but its employment was delayed from the very magnitude of its success—the explosions were too violent. These explosives could not be used in guns, because they would burst the gun; nor in shells, because even if they would stand the shock of firing, they would shatter the shell into too small fragments to be effective. So the use of these early high explosives in war, except for blasting or like destructive purposes, made little advance for many years, until it was discovered that by dissolving them in some volatile solvent, and subsequently driving it off, there was left a substance resembling gelatine which could be cut into pieces of any desired shape or size. It possessed all the power of the original explosive, but its rate of burning was wholly different. You will understand the reason of this when I say that though it was a true explosive, burning with extreme rapidity, it was a poor conductor of heat. When the charge was fired, all the pieces commenced to burn on the surface, and the combustion was so rapid that it spread itself through each piece of the material more quickly than the high temperature could arrive at the centre of that piece by conduction of heat. Hence it followed that the pieces always burn from the outside inwards, and the explosion never commences inside the piece, so that by changing the shape and size of the pieces into which the material was cut, and thus making the amount of their surface large or small compared with their bulk, you can make a powder which would burn more or less quickly. For instance, a favourite method of increasing the rapidity of burning is by perforating the pieces so as to increase the surface without increasing the bulk. In this way, there could be made out of the same substance powders suitable for small arms which required a very rapidly-burning powder, and for large guns which required a comparatively slowly-burning powder. You must understand that I am using the words quick and slow in a comparative sense only. The actual time required is always small. In the biggest gun loaded with the coarsest powder, the time of the burning of the charge would be something of the nature of one twenty-fifth of a second.

But the quality which caused the discovery of these gelatinized powders to revolutionize tactics, both by land and sea, was that they were smokeless. In gunpowder there is much that takes no part in the combustion and is expelled as fine dust. It is this which causes the smoke which always accompanies the use of gunpowder, and which not only fouls the gun, but made aiming an impossibility after the first volley in continuous firing. The great feature of Admiral de Saumarez, the local hero of Guernsey, was that he drove his frigate by night

between two French men-of-war that were lying parallel to one another, and fired simultaneously both his broadsides at them, and then sailed away, leaving each to blow the other out of the water in the belief that it was firing at the adversary that had dared to attack it. The clouds of smoke prevented either discovering its mistake.

But in the new powder nothing is left unconsumed. The whole is turned into invisible gas. Aiming, therefore, continues possible; indeed, each shot is a sighting shot for the next. This makes it imperative that the position of guns should not be altered by firing, in order that they may correct their aim by past results; and they are therefore mounted in cradles with arrangements to take up the recoil, and return the gun to its original position after firing. Quick-firing and machine-guns can be used with accuracy, and their use is now the fundamental consideration in much of our military tactics. It would be hard to exaggerate the extent to which military science had been changed by this invention of smokeless powder.

Big Bertha Explained.

But science has not completed its service to war in respect of explosives when it had thus endowed it with a perfect propellent. There remain the high explosives with their tremendous pressure. Recent measurements of pressures produced instantaneously by high explosives point to a figure of 300 tons per square inch. But this inadequately expresses the contrast between them and those others of which he had been speaking. It took no notice of the rate at which the pressure rose. The rate at which that pressure comes on in a 6-in. gun has been found to be about 10,000 tons per second, so that it rises to the full pressure of 15 to 20 tons in something under the five-hundredth part of a second. In a rifle, the rate of rise is perhaps ten times as great, but the period is proportionately shorter. In a good high explosive, the rate of rise per second was several millions of tons per square inch, and the period was a fraction of a thousandth part of a second. Hence the shattering effect of these high explosives.

Such violence of explosive force is just what is needed for shells, provided that the explosives are not too sensitive, or, in other words, that they stand the shock of the discharge of the gun without exploding. But here a strange peculiarity shows itself. They have two ways of exploding. The one gives a comparatively mild explosion, comparable, say, with that of gunpowder; the other, a fierce detonation, the violence of which is akin to that of guncotton. No one has penetrated the mystery of this. It undoubtedly depends on the initial disturbance which sets the explosive off. If that is of a sufficiently intense type, and is rightly communicated to the mass of the explosive, it produces detonation, and the shell is rent to pieces. If not, we have only an explosion which opens out the shell, but does little more. It needed much research to give us practical control of high explosives in this respect. In the Boer War we used lyddite in our shells—a high explosive of the finest quality; but we did not know how to detonate it with certainty, and in only one type of gun was it of use. By the commencement of the present war we had, however, learnt how to detonate with fair, but not absolute, certainty the high explosives then used in the service. But soon

afterwards the prospect of our supply of toluol failing to equal the enormous demands of our shells necessitated a change of high explosive, and the one that was taken required special study before detonation could be insured. It was achieved through the unremitting labour of those scientific workers who, little known to the public, have had to face and solve the innumerable problems that have presented themselves in the preparation and use of explosives during the war, and to whom personally I feel deeply grateful. Through their labours we arrived at a degree of excellence which reduced the proportion of the shells which failed to detonate from all causes to so small a figure that it was, I believe, little more than one-fifth of that of our adversaries. It would take an artillerist to explain to you the changes in tactics brought about by the scientific work that has given us these reliable explosives. It has endowed us with heavy guns, having ranges of from 20 to 30 miles, and even more important howitzers which have been so effective at shorter ranges. For instance, we had howitzers which at ranges such as 8 to 15 miles could be relied on to fire shot after shot with a variation of a few yards. The history of our advance in artillery is a fascinating tale of difficulties met and over-

The most striking example of the power placed in the hand of man by this complete control over propellents was provided early last year, when the whole world was thrown into amazement by the report that Paris was being bombarded by the Germans, who could not be firing from a point less than 70 miles from it. The world was at first incredulous. Then, as usual, it credited the Germans with having invented some new propellent of marvellous efficiency. But our artillerists knew better. They realized that, thanks to the control of pressures and rates of burning in our present smokeless powders, such a range could be obtained in a gun of determinable dimensions if it were worth our while to do it. Indeed, the whole details of the gun and the powder necessary to accomplish the feat were at once worked out, and the gun would have been manufactured if it had possessed sufficient military value to warrant the work and expense. But it did not. In its flight the projectile from Big Bertha must have reached a height four times as great as Mount Everest, the highest mountain in the world. It owed its longest range to the fact that during two-thirds of its flight it was passing through regions where the air was so rarefied that its resistance was negligible. And, finally, the distance passed over by the projectile was so great that if the Germans had taken the trouble to aim at any particular building they must have allowed nearly half-a-mile for the fact that during the flight the rotation of the earth would to that extent carry the target further towards the east than it would carry the gun.

Saving Verdun.

Take the internal combustion engine as an illustration that the special formative factors of the late war were not the result of purely military science, but of the advance in peaceful pursuits. Such an engine needed no supply from outside except petrol. To it we owed the aeroplane and tank, the submarine, and the possibility of a road motor service which had shown itself capable of rivalling railway

transport. The greatest triumph of this engine was in motor transport. It was our main agent throughout the war in supplying our armies with necessaries. In one respect the Germans outdistanced the Allies throughout—in the attention they paid to strategical railways.

In this part of their organization the Allies were inferior to the enemy, and motor transport had to make up for their deficiencies. On one critical occasion it saved the war. In 1916 the Germans concentrated their efforts on Verdun. The Germans had ten strategic railways on their side; the French had but one second-class railway and road communication. Yet their heroic defence was successful. Along the main road leading to Verdun the French organized a motor transport system which was a marvel.

Chemical Warfare.

The next great scientific discovery which had proved a formative factor in this war was wireless telegraphy. The most hateful chapter of the work of science in war was the introduction of chemical warfare. The first gas attack on 22nd April, 1915, and the five others that followed within little more than a month found us wholly unprepared, and it was not until September that we were able in any way to retaliate. But our immediate reply was one that did honour to science. Due to the splendid work of the late Colonel Harrison a system of defence by gas mask was established, in which we were for the greater part of the war far ahead of our adversaries, who only succeeded in coming up to us by learning and copying our methods It was impossible to estimate what would have been the destruction caused by toxic gases but for these defensive measures.

Tetanus and Spotted Fever.

The use of the anti-tetanus serum became a routine treatment, and proved so successful that unless it was administered too late so that the work of the microbe was already too far advanced it might be relied on to prevent any development of the disease. The râte of mortality in spotted fever had been reduced to about one-tenth of its former value. The crowning triumph in this field was the complete elucidation of the mode of transmission of bilharzia, a disease with which we were faced through the presence of large contingents of our troops in Lower Egypt.

Folly and Warning.

In all these instances both combatants had to a more or less equal degree shared in the help that science had given. But there was a glaring exception. All explosives, with a few unimportant exceptions, depended on the use of nitrates, and until a few years ago they were supplied from the natural deposits of nitrates found in Chile. Science then showed that they could be made directly from the nitrogen of the atmosphere. Our Government and our industrials took no heed of these discoveries; it involved less trouble and less expense to continue to get them from Chile. It was otherwise with Germany. They realized that to be able to make their nitrates at home rendered them

independent of the command of the sea for a substance essential to their production of explosives. They therefore developed the processes on a huge scale, and it was not until these factories were at work that they ventured to declare war. But for the existence of those factories the war could not have lasted six months.

There was one over-mastering lesson to be derived from the contemplation of all that science had done in the war. She had made mankind too formidable a being to be permitted to have recourse to it. The uncontrolled indulgence either on the part of a nation or of an individual in the exercise of the powers that science had placed within his reach was too directly fatal to civilization itself. It was easy to criticise the League of Nations and to point out the difficulties and even impossibilities with which it was faced, but let us never forget that some combined action of that type was an imperative necessity.

Science, like charity, should begin at home, and has done so very imperfectly. Science has been arranging, classifying, methodizing, simplifying everything except itself. It has made possible the tremendous modern development of the power of organization which has so multiplied the effective power of human effort as to make the difference from the past seem to be of kind rather than of degree. It has organized itself very imperfectly. Scientific men are only recently realizing that the principles which apply to success on a large scale in transportation and manufacture and general staff work apply to them; that the difference between a mob and an army does not depend upon occupation or purpose but upon human nature; that the effective power of a great number of scientific men may be increased by organization just as the effective power of a great number of labourers may be increased by military discipline.

— Hon. ELIHU ROOT.

Cotton Growing in Australia.

Revival of Interest.

Introductory.—Every effort is now being made in Queensland to revive interest in the cotton-growing industry. From a variety of causes, which it is not necessary to traverse in detail, the industry has had its ups and downs, and although, as a rule, the acreage has remained small, authorities on sub-tropical agriculture feel confident that not only in this State, but in other portions of the Commonwealth, cotton-growing is capable of considerable extension upon a commercial basis.

As far back as 1858 the establishment of the industry was strongly advocated by Dr. Lang, who had made successful attempts to cultivate cotton in New South Wales. In 1861, upon the outbreak of civil war in North America, prices rose to a high figure, and Queensland was able to supply relatively large quantities of the world's requirements. Prices, however, fell rapidly at the conclusion of the war, and Queensland's activities dwindled in consequence. The early eighties saw a renewal of effort, which was marked by the formation of the Ipswich Cotton Company and the manufacture in Australia of cotton goods. The mill eventually passed into the hands of Joyce Brothers. The industry, however, again declined, but was carried on in a small way by a few growers. In 1902, when Australia was in the grip of a particularly bad drought, the Queensland Government, through the Department of Agriculture, in order to encourage the cultivation of cotton, not only for the lint, but also as a fodder crop for emergency purposes, undertook to supply seed, receive the crop, gin and sell it on the owners' account, and to make an advance when the raw cotton was received into the store. The acreage again began to extend. As the result of war conditions, the net return to the grower has been as much as 4d. per lb., which, on a yield of 1,000 lbs. per acre, is equivalent to nearly £17 per acre.

The principal economic consideration was, of course, the price obtainable. There was, however, another aspect which is important and interesting. In the early days a great proportion of the seed which was cultivated was of the Sea Island cotton, but recently Upland American cotton was introduced, and produces almost the whole of the lint placed on the market. It is regarded as excellent in quality. Suitability of varieties must be determined before permanent and satisfactory progress can be made.

In its present campaign, the Queensland Department of Agriculture does not favour a return to the plantation or large area system, and strongly urges the cultivation of a few acres on a farm as a subsidiary crop. Its reason for so doing is twofold. In the first place, the Kanaka labour that was available in the plantation period is not now to be obtained; and in the second place, a grower can handle, say, 10 or 12 acres without recourse to additional and temporary assistance. Later, if the cultivation of cotton becomes an established industry, the areas would naturally be enlarged in proportion to the profits derived.

Special Committee's Report.—When the possible re-establishment of the industry came to be considered, the Queensland Committee of the Institute of Science and Industry displayed an active interest in the question, and upon its recommendation the Executive Committee of the Advisory Council appointed the following gentlemen to report upon the matter:—Messrs. J. B. Henderson, E. G. Scriven (Under-Secretary, Department of Agriculture), N. Bell, D. Jones, and Professor B. D. Steele. Prior to this the Institute had interested itself in one or two phases of the industry, such as the perfection of a mechanical cotton-picker, and the investigation of varieties. Immediately upon its formation, the Cotton-growing Committee made a careful survey of all available evidence, and submitted the following statement to the Executive:—

The causes of the past failures are many and complicated—different causes appearing to preponderate on different occasions. Amongst the adverse conditions that have operated, the following may be mentioned:—

(1) Cost of transport to the world's markets during periods of low price.

(2) Lack of local market which would absorb the crops during such period.

(3) Competition with other crops believed at the time to be more profitable, accentuated by the smallness of the agricultural population in Queensland.

(4) The cultivation of unsuitable varieties of cotton.

Plants of the cotton family are indigenous to Queensland, and it might, therefore, be expected that such plants would thrive in this climate. The experience of the past sixty years confirms this expectation, and from all the evidence available it may be taken as established that in a great number of districts in this State climate and soil are entirely favorable to the production of good crops of cotton of excellent quality. Moreover, the cotton appears to be more resistant to drought than certain of the local staple crops, such as potatoes and maize. It has proved also a good reserve in drought as a stock fodder.

It becomes necessary, therefore, to ascertain whether the causes to which the former failures are to be attributed are still operative.

Considering first the question of growing for export, it is clear that Australia labours permanently under the dual disadvantages of distance and of competition with other countries where abundant cheap labour is available. It is, however, quite possible that the growing of a long staple variety suitable for export may enable these disadvantages to be successfully overcome.

Looking at the matter from the point of view of the local market, the possible outlets for raw cotton are—

(1) The manufacture of nitro-cotton by the Commonwealth Explosive Factory. This offers an immediate demand for a limited quantity of cotton. The annual demand of the factory is about 50 tons.

(2) The manufacture of mixed cotton and woollen goods. This outlet is also limited, but in 1916 and 1917 a total of 282 tons of cotton was imported from the East for this purpose, in addition to 25 tons of Queensland cotton sold in Australia for that purpose.

(3) The prospective manufacture of cotton goods in Australia. That is, as indicated, prospective, and past experience at Ipswich leads us to the conclusion that its development will depend largely on fiscal policy pursued by the Commonwealth Government.

The utilization of the cotton seed by the manufacture of cotton seed oil and other by-products will yield further returns, and must be taken into account.

We are of the opinion that the present consumption of raw cotton in Australia is sufficient to give the cotton industry every opportunity of becoming established as a staple primary industry. If this opinion is correct, it becomes necessary to consider what will be the best methods to adopt to encourage its development.

We consider it necessary—

(1) To take every possible precaution to prevent the introduction from America or elsewhere of the various cotton pests. With this object in view, all imported seed should be propagated in quarantine before distribution.

(2) To ascertain the most suitable varieties of cotton to meet—

(*a*) the requirements of Australian consumers;

(*b*) the climatic and soil conditions of the districts in which cotton can be grown with advantage;

(*c*) the possibility of using the mechanical picker.

(3) To encourage farmers to grow each a few acres of cotton as an auxiliary crop, rather than prematurely to reintroduce the plantation system.

This mode of procedure is advisable as presenting the dual advantages that the farmer is not at the mercy of a possible failure of a new type of crop, and that a crop of a few acres could be picked by a family of average size without employment of casual labour.

We would suggest that the following methods of encouragement might be adopted:—

(*a*) Propaganda with issue of suitable bulletins.

(*b*) A continuation of the State Department of Agriculture's system of ginning and marketing on owners' account.

(*c*) A guarantee by the Commonwealth Government for five years of an amount certified to by the State Department of Agriculture that will enable the grower to receive 4d. per lb. for seed cotton on the farm.

(4) To stimulate similar development of the industry in States other than Queensland on the grounds that the larger the production of raw material the more likelihood there be of the establishment of factories for the manufacture of cotton goods. Once these are fairly established, the stimulus between the primary and secondary industries will be mutual.

(5) To continue experiments that have been started aiming at the production of a cheap and efficient form of mechanical cotton picker.

From such information as is available this Committee concludes that sufficient protection will be afforded without the imposition of any Customs duty. Stringent quarantine regulations must be prescribed and rigidly enforced.

To assist in doing this, we recommend that a limited number of ports of entry be prescribed, and that adequate fumigation chambers and plant be installed at each of these ports. By this means the introduction of pests will be prevented, and, at the same time, the cost of fumigation, which should be paid by the importer, will afford appreciable and adequate protection to the growers.

The Committee consider it absolutely essential, if the introduction of pests is to be prevented, that this fumigation should be established apart from any question of protection. As kapoc is imported from the East in quantities, it is considered essential that it should also be fumigated on importation.

(NOTE.—It has been reported to us that soldiers and others are introducing small quantities of cotton seed into the country, chiefly from Egypt. There is grave danger of the introduction of Pink Boll Worm and other pests into the county by this means.)

Any attempt to encourage the growth of cotton in Australia should have as its ultimate aim the establishment of a cotton manufacturing industry in the country. Past experience at Ipswich teaches us that such an industry cannot flourish without some measure of protection. As soon as the production of cotton has reached the stage where it can more than satisfy the requirements of the present consumers of raw cotton in Australia, the question of the imposition of a duty on manufactured goods and the amount of protection needed will become an urgent one.

In the meantime, it is the duty of the growers to demonstrate that they can profitably meet all present requirements.

Action taken by the Institute.—The Executive Committee has for some time been of the opinion that the most hopeful method of solving the labour problem is by the introduction of a mechanical picker, which would obviate the necessity of hand-picking. Inquiries were consequently made from numerous sources in the United States, and a good deal of information was obtained on the subject. As the result of a number of laboratory experiments, a machine has been devised, and is now being constructed, which it is considered will survive all practical tests, and fufil the requirements for which it is intended. There is a limit, however, to the powers of this machine, or, indeed, of any

type of mechanical cotton picker, inasmuch as tractable varieties alone of cotton can be picked. Mr. Daniel Jones considers that the tractable type can be grown at the same value as the intractable type, and that the quality is merely a question of cultivation and seed. To this end, therefore, he has secured certain varieties from various places in Queensland, and they are being cultivated near Brisbane. A practical test of the picker should, therefore, be possible during the next autumn.

In addition to the seed already introduced into Queensland, the Institute has made arrangements for the importation of seed from the United States. The request sent to the Bureau of Agriculture was for the high commercial varieties grown in localities whose climate is similar to that of Queensland, and steps have been taken to have all imported seed thoroughly fumigated to prevent the introduction of pests. Upon its arrival the seed will be treated at the Department of Agriculture, Brisbane, and will be grown under the supervision of officers of that Department.

In view of the recommendations of the Queensland Committee, the Executive Committee gave close consideration to the question of a guaranteed price for a number of years. The conclusion arrived at was that the Commonwealth Government should be recommended to guarantee the grower 4d. per lb. for seed cotton for the crop to be harvested in 1920, and the price for succeeding years to be adjusted according to the world's price and to local requirements. At the present time the Liverpool price for ginned cotton is 1s. 6d. per lb., and as it takes 3 lbs. of cotton in the seed to make 1lb. of ginned cotton, it was considered that the price agreed upon, while offering profitable returns to the grower, would not commit the Government to any great financial risk.

It is officially estimated that an average crop of cotton in Queensland should produce 1,000 lbs. per acre, which would represent, at 4d. per lb., a gross return of £16 13s. 4d. per acre. Allowing £5 per acre for working expenses (planting and cultivation £2, and harvesting £3), the net return would be £11 13s. 4d. With the prospect of securing such prices, the Department of Agriculture anticipates a considerable extension of the acreage for this year, and a general stimulation of the industry.

"If industry wants men of scientific ability who have taken a College course extending over four or five years, it must be prepared to pay for them. To offer salaries of £100 to £150 a year with very indefinite prospects of future advancement is useless. The salaries and prospects of advancement must be such as to induce able young men to continue their education up to the age of 22 or 23 and to persuade poor parents to bear the additional burden involved."

—***Science Progress.***

The Flax Industry in Australia.

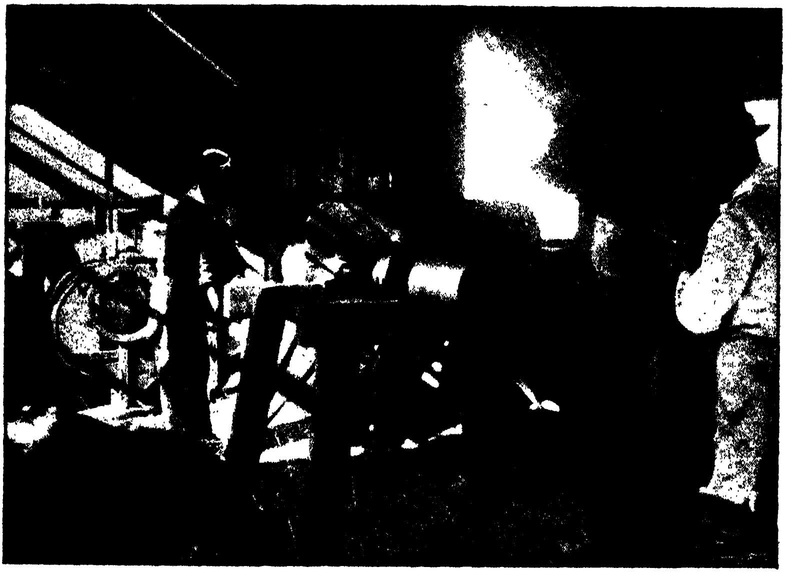
By R. B. WARD.*

THE INCEPTION OF THE COMMONWEALTH SCHEME.

BEFORE the war, Russia produced no less than 80 per cent. of the world's output of flax fibre, and when the greater part of the Baltic provinces fell into German hands, as well as the flax-growing districts of Belgium, Northern France, and the Balkan Peninsula, the shortage of flax fibre among the allied nations, for both military and commercial purposes, became every day more and more acute.

The Imperial Government offered, and is still offering, special inducements to the farmers in the British Isles to increase the cultivation of this crop, recognising that whatever might be the ultimate fate of these districts, it was extremely undesirable that the Empire should remain dependent upon outside sources of supply for the raw material of such an essential industry, both in peace and war.

When therefore a meeting of agricultural scientists was held in Melbourne in November, 1917, at the instigation of the Advisory Council of Science and



THRESHING FLAX.

The head of the sheaf is passed between the revolving rollers, which crush the seed-bolls and free the seed, which is subsequently winnowed.

Industry, it was only natural that one of the many subjects listed for discussion should be the possibility of successfully cultivating fibre plants in Australia. As the result of that discussion, a resolution was carried that the Advisory Council be asked to ascertain whether the British Government was prepared to purchase dew-retted flax fibre from Australia in 1919, and if so in what quantities and at what price. Inquiries were instituted accordingly, with the result that the Army Council in England agreed to purchase the fibre from the 1918 flax crop at £170 per ton c.i.f. The Commonwealth Government thereupon, on the recommendation of the Advisory Council, appointed a Committee, under War Precautions Regulations, for the control and the development of the flax industry in Australia, at the same time guaranteeing all growers of fibre flax in 1918 £5 per ton for flax of specified standard.

* Secretary, Commonwealth Flax Industry Committee.

The Committee, at its inception, consisted of Mr. Thomas Hogg (Chairman), representing the Advisory Council of Science and Industry; Mr. J. E. Robilliard, of the Agricultural Department of Victoria, as agricultural expert; and Mr. E. R. Morton, of Drouin, as the representative of the growers. After a few months, the Committee was unfortunate in losing the services of Mr. Hogg, who was compelled to resign through ill-health, his place in the Committee being taken by Mr. A. C. Downs. The Committee was, however, considerably strengthened by the appointment of two additional members, Dr. S. S. Cameron, Director of Agriculture of Victoria, who was appointed Chairman; and Mr. A. E. V. Richardson, M.A., B.Sc.

PREVIOUS EFFORTS TO ESTABLISH THE INDUSTRY.

For the past twenty years or more, fibre flax has been grown on a limited scale in the Gippsland district of Victoria, and attempts have also been made at various times to introduce its cultivation into New South Wales and Tasmania, but without success. Owing to the scarcity and high value of labour, and the low price at which flax fibre could be imported, the return the Australian farmer received for his flax did not prove sufficiently attractive to encourage its cultivation, and the one or two attempts that were made in recent years to establish the flax industry on a larger scale in Victoria ended so disastrously as to prejudice him still further against this crop. The Bounties Act, passed by the Commonwealth Government in 1907, provided for the payment of bounty of 10 per cent. of the market value of all products from flax grown in Australia; but so little was this inducement availed of, that when the Act expired in 1917, not more than 300 acres of flax was under cultivation. It is doubtful whether the bounty system, lacking as it does both educational and controlling features, is the most effective method of encouraging or establishing a new industry.

EUROPEAN AND AUSTRALIAN CONDITIONS CONTRASTED.

It is more than likely that, in addition to the low returns for fibre and the comparatively high cost of labour, one reason for the retarded development in the establishment of the flax industry in Australia was the difference in climatic conditions as compared with those of the fibre-producing lands of Europe, and particularly with those of Ireland, in which country most of the farmers who have attempted flax cultivation in the Commonwealth originally gained their experience of this crop.

In Ireland the practice is to grow for fibre only. The crop is pulled when green, with the result that the seed is immature and never ripens; and, prior to the war, each year's sowing requirements were imported from Russia or Holland. In Australia the crop is harvested at a later stage of its development, and the climatic conditions are such that the seed attains maturity in the seed boll, while the sheaves are still standing in the fields. Fibre and seed are thus obtained from the one crop. To what extent, if any, the fibre yield is affected by this later cutting is problematical. Old North of Ireland growers still contend that the Australian method results in a poorer quality of fibre, although in the linen trade journals at the present time the advisability of following the Australian method and growing for both fibre and seed is being debated. Irish flax is usually water retted, the straw being placed in pits or dams, and then covered with water, when the fermentation necessary to dissolve the pectine or gummy portion of the stalk is effected. The system adopted in Australia is that of "dew" retting, the straw being spread over the paddocks in thin layers, and the fermentation being brought about by the action of the dew and the sun. Again, in Ireland, and in all the European flax-growing countries, the custom is to pull the crop by hand, while in Australia it is cut with a reaper and binder. There appears to be no doubt that cutting is wasteful, besides being detrimental to the production of first quality fibre, but the loss sustained by the Australian grower through the adoption of this method is probably more than compensated for by the greatly decreased cost of labour.

Enough has been written, however, to show that the flax-growers in Australia have had to learn by the practical experience of local economic and natural conditions, and that the methods of cultivation and treatment that have proved successful in Europe may not be equally so in the Commonwealth.

THE WORK OF THE FLAX INDUSTRY COMMITTEE.

When the Committee was appointed, its first act was to requisition all the seed from the previous year's crop. In view of the limited quantity available,

the Committee decided, as far as growing flax on a commercial scale was concerned, to concentrate its efforts for 1918 to Gippsland, where it was known that flax could be grown with success, and where one or two flax mills were already in existence.

The seed at the Committee's disposal was grown in the Drouin district, and was of the variety known as "Blue-flowering Riga," the descendant of a small consignment imported some years ago. The quantity available was only sufficient to sow about 1,400 acres, and for a time the advisability of obtaining a further supply from New Zealand was seriously considered. On examination of the samples submitted, however, some doubt arose as to the fibre-producing qualities of the imported seed, and it was decided to utilize only the acclimatized Victorian seed. The wisdom of this determination was proved subsequently by the results of experimental sowings of the New Zealand variety. At Drouin, at the same time and under similar conditions, an acre was sown with the New Zealand seed, and several acres with Victorian-grown seed; but whereas the latter produced one of the best crops in the district, the crop from the imported seed was of so little value as regards either fibre or seed that it was never harvested.

FLAX MILL, GIPPSLAND, VICTORIA.

The building was not quite finished at time of photographing. The mill was erected by the Commonwealth Flax Committee, and the treatment of the flax is being carried out by a co-operative company of growers.

It cannot be too strongly emphasized that, in any attempt to open up a new agricultural industry, the matter of seed selection is of vital importance.

Had this New Zealand seed been sown in any new district, the failure of the crop would doubtless have been attributed to the unsuitability of the district for flax, with fatal results to the local establishment of the industry.

The Committee, having disposed of the whole of the available seed, was then faced with the greater difficulty of preparing for the treatment of the crop, which, with a normal season, was estimated at about 2,000 tons. As the two existing mills in the Drouin district were quite inadequate for the treatment of this quantity, the Commonwealth Government agreed to the Committee's recommendation that a sufficient sum be advanced to the millers at Drouin for the purpose of extending their plant, and also approved of financial assistance being granted, in the form of either money or machinery, to any body of growers who might desire to erect a co-operative mill in their own district. As a result, two flax-milling companies have been formed, one at Dalmore, on the

reclaimed Koo-wee-rup swamp; and the other at Buln Buln, some 6 or 7 miles distant from Drouin. At the latter place, the Commonwealth Government is erecting an entirely new plant, while the Dalmore Company has been supplied with a mill purchased from the Victorian Government, and originally installed in the Penal Establishment at Pentridge, for the treatment of flax by prison labour.

Owing to the very limited and inconclusive data available as to the cost of milling, the Committee had great difficulty in arriving at an equitable basis of payment for the treatment of the crop, but an agreement was at last made with the millers whereby the latter treat the flax, and deliver all the products to the Committee; while the cost of the treatment is paid for on a percentage basis of the net income derived from the products. A system of time-sheets has been installed in each mill, whereby the cost of each process of treatment is segregated, and next year the Committee should be in a far better position to judge what is a fair remuneration to the millers.

THE 1918 HARVEST.

Owing to the exceptionally dry spring, the early anticipations of a record harvest were not realized, but nevertheless the average yield of flax was, considering the very dry spring, a satisfactory one.

Appraisers were appointed at the time of harvesting to inspect and value each crop, and 1,800 tons were delivered for treatment at the various mills.

As was inevitable in what was to many growers a new venture, the lack of the necessary experience militated in some cases against the best results being obtained, but the average price paid, £4 15s. per ton, is evidence of the comparatively high standard of the crop.

The treatment of the flax at the mills will not be completed before the end of the present year, but it is estimated that flax products to the value of approximately £23,000 will be obtained.

It is more than likely that, with the experience gained in both the cultivation and treatment of the 1918 flax, more profitable results will be obtained from succeeding crops.

THE 1919 CROP.

As there was every indication of continued high prices for flax products, the Flax Committee had no hesitation in recommending the Commonwealth Government to extend the guarantee to the 1919 crop, as it considered that, while last year's guarantee undoubtedly had given a much needed impetus to flax cultivation, further encouragement was necessary in order to place the industry on a surer footing. At the same time, it was thought that, in view of the high returns received by farmers at present for other agricultural products, such as hay, potatoes, and butter-fat, the guarantee of £5 per ton was hardly a sufficiently attractive proposition, and an increase of the guarantee to £6 per ton was therefore recommended.

The Commonwealth Government adopted the Committee's recommendations, and subsequently an agreement was made with the Imperial Government for the purchase by the latter of the 1919 fibre on the same terms as previously given, viz., £170 per ton c.i.f.

The area sown this year is approximately 2,250 acres, an increase of over 50 per cent. on the acréage of 1918.

The cultivation of flax has been introduced into several new localities, 700 acres having been sown this year in the Sale and Thorpdale districts, while in the Western and Central districts many farmers are growing this crop for the first time on a commercial scale.

Provision will have to be made for the treatment of crops in those districts where milling facilities are not now existent, and the establishment of flax mills on a co-operative basis seems to offer the most satisfactory solution.

THE FLAX INDUSTRY IN AUSTRALIA.

While fully assured that the flax industry can be established in the Commonwealth on a sound and profitable basis, the Flax Committee considers that the most effective means of doing so would be a continuance of the present system of Commonwealth control. A recommendation, therefore, has been made by the Committee to the Government that a guarantee of £5 per ton for standard flax be given to growers for a further period of three years, and the matter is now receiving Ministerial consideration.

INVESTIGATIONAL WORK NECESSARY.

The flax industry is relatively new to Australia, and the Committee was not long in discovering the lack of exact knowledge of this crop, and the existence of many misconceptions and prejudices.

For instance, the most suitable methods of cultivation, the fertilizer requirements, the system of rotation cropping best suited for flax, had still to be

STACKING DEW-RETTED STRAW.

In the foreground can be seen the straw spread out for "dew-retting."

determined; while on the manufacturing side no definite data was available as to the factors governing the yield of fibre and the cost of production.

It was recognised that, without definite and exact information, the result of carefully conducted tests and investigation, the industry would rest on an empirical basis, and would be unable to compete with the highly organized fibre industries in other parts of the world.

Representations to this effect were therefore made to the Commonwealth Government, and in consequence a grant of £1,000 was made to the Committee for experimental work.

With this sum available, the Committee has been enabled this year to institute a series of experiments in all the States, in most cases with the co-operation of the State Agricultural Departments, and while the results obtained from one year's experimental work cannot be expected to be entirely conclusive, they should determine many points on which definite information is at present lacking.

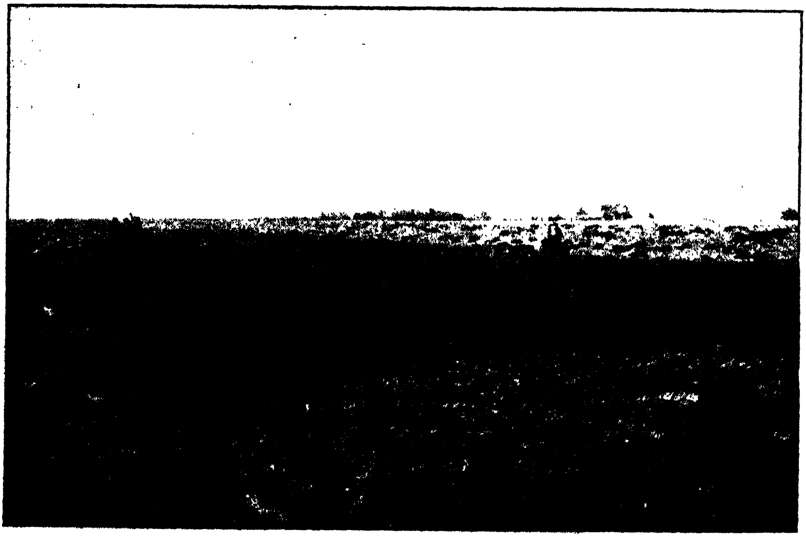
It may be stated that the Committee noted with some surprise the comparatively primitive plant and machinery used in flax treatment.

As far as can be ascertained, little mechanical progress has been made in European flax mills for the past 50 years, and there appears to be a wide field for investigation into the more economical methods of treating flax, more particularly with regard to mechanical appliances.

AUSTRALIA'S PRESENT OPPORTUNITY.

With regard to future prices for flax fibre, the opinion is held in British linen trade circles that, despite the cessation of hostilities, the depletion of the world's stocks of fibre during the war must inevitably result in the supply for many years being unequal to the demand, and that high values will rule in consequence.

Even assuming that in a few years Russia will be in a position to resume flax cultivation on her pre-war scale, far-reaching changes in her economic position seem inevitable, and it is more than doubtful if fibre values will ever decline to their former level.



HARVESTING FLAX WITH REAPER AND BINDER, GIPPSLAND, VICTORIA.

The *Irish and Scotch Linen and Jute Trade Journal*, the recognised organ of the flax trade, in its issue dated December, 1918, makes the following comment:—"It may be accepted as pretty certain that remunerative prices will rule for ten years. Since the outbreak of war, the stocks of linen throughout the world have been depleted, and supplies of household linen have reached vanishing point. These stocks will have to be replenished, a task that will take years, and in addition there will be a big demand for aeroplane sheetings for commercial and other purposes."

The following official statement was issued in April of this year by the United States Bureau of Foreign and Domestic Commerce:—"The war has created a situation where the American flax and linen industry has an opportunity never before offered, and which it may never have again." This argument applies with equal force to Australia.

From a national stand-point, the successful establishment of this industry may be considered very desirable for a number of reasons. Not only would it prove a profitable venture to the farmer, but it would assist in the much needed diversification of Australian agriculture. Moreover, the returns of linseed would make a valuable contribution to the increasing demand within the Commonwealth for linseed oil and meal.

Again, it is not unreasonable to assume that the placing of the industry on a sound basis would result in the creation of a new manufacturing industry, as it has been estimated that the annual cultivation of approximately 12,000

acres would justify the establishment of spinning mills for the production of linen fabrics.

And, finally, the importance of this industry from an Imperial stand-point must not be lost sight of.

In a report issued in December, 1918, by the Empire Flax-growing Committee, a body appointed by the Imperial Government to investigate in all its bearings the question of increasing the supply of flax within the British Empire, the opinion is expressed, "That the great efforts made to increase the Empire's resources should not be relaxed now that civil rather than military considerations have weight, and any withdrawal of Government control which might lead to the diminution of flax-growing within the Empire, would not only be a waste of the money and effort already expended, but would be very much to be regretted in the interests of the linen trade."

As it has been demonstrated beyond doubt that many parts of the Commonwealth possess all the essentials in both soil and climatic conditions for the successful cultivation of this crop, neglect to take full advantage of the present opportunity would be a serious reflection on Australian initiative and enterprise.

When our local Department of Agriculture was established 27 years ago with a small scientific staff consisting of a vegetable pathologist, botanist, entomologist, and chemist, there was just the same shaking of wise heads as one anticipates now. Certainly the farmers, who were to benefit the most from the future operations of the young Department, were amongst its most scornful critics. The idea that the scientific man could be of any assistance to the so called "practical" farmer was considered ridiculous. Surely the old cow knew better what kind of food was good for her than did the chemist with his "balanced rations," and so the old cow went on "blowing" herself on clover or ate immature sorghum and poisoned herself with Prussic acid.

—F. B. GUTHRIE.

The Potash Situation.

By HEBER GREEN, D.Sc.

(Secretary of the Chemicals Committee of the Institute.)

THE greater part, possibly 80 per cent., of the world's pre-war supply of potash salts came from Germany, and the market was controlled by the semi-government Kali-Syndicat. When exportation was stopped during the war the shortage led to a quest for other sources of supply, and many proposals were made for working up materials previously untouched for this purpose.

This search had, indeed, been developing for some years previous to the war in consequence of the German firm having advanced their charges for potash salts; and particularly in America many experiments had been in progress to test other sources.

OTHER SOURCES.

Although the occurrence of soluble potash salts of a high grade is limited to comparatively small areas, yet felspars, and other minerals containing insoluble silicates of potash, are widely distributed practically all over the globe. The insolubility of the potash, however, implies its unavailability as a plant food, and consequently agricultural experiments with felspars, even when finely powdered, have been discouraging. It was more profitable to pay the increased price for German potash salts; and, in spite of several attempts, the chemical problem of rendering felspar potash soluble is still commercially unsolved, and a legacy for future generations.

During the war, the price of potash in America rose from about £9 per ton to over £80 per ton. In Australia, however, such extreme figures must be regarded as merely nominal; for its use in any quantity as an agricultural fertiliser would be unprofitable in this country if it cost more than about £60 per ton of pure potash.

Nevertheless, these high war prices have stimulated the hunt, and the enormous kelp beds off the Californian coast have been worked on a large scale; but though they yielded other by-products as well as potash, it is stated that none of the companies operating have been financially successful. Brine and salk lakes have been more generous in their yield of potash, and last year the Californian works alone at Searles Lake turned out about 10,000 tons of "potash." An account of the efforts made in America to produce their own potash is given in the *Journal of Industrial and Engineering Chemistry* (1918), vol. 10, pp. 832-844.

In 1917 the discovery was made that the flue dusts from cement works and blast furnaces contained, in some cases, surprisingly large amounts of potash, and the statement was officially made that the problem of potash supply for Great Britain was solved not only for the duration of the war, but thereafter. Large quantities have been obtained from these sources.

The quest for potash has been world wide, and minor deposits have been discovered in Abyssinia, Spain, and other countries; and even Australia, so comparatively little affected by the war, has been compelled to join in the hunt.

THE SEARCH IN AUSTRALIA.

Some £30,000 to £40,000 worth used to be imported annually, consequently the Institute of Science and Industry has given considerable attention to a number of suggestions that have been made; and several investigations that they have undertaken or instigated may be mentioned.

1. *Kelp.*—A Special Committee was established in Tasmania to investigate the commercial possibilities of the utilization of kelp. It was found that the potash content varies in the different species, but is never sufficiently high for profitable extraction under Tasmanian conditions.

2. *Lake and Mineral Spring Waters.*—As a rule, in the analyses available, the potash has not been separately determined, and where it has, no cases have been noticed of any large content of this alkali. A systematic examination of these natural resources is called for, however, and has been recommended for inclusion in the early activities of the permanent Institute.

3. *Alunite.*—There are large deposits, said to be the most extensive in the world, of alunite at Bulladellah, in New South Wales, and at Carrickalinga, in South Australia. In its natural state, this basic potassium and aluminium sulphate is insoluble and difficult to treat, so what little has been mined has been shipped to Europe for extraction of the potash and alums.

A Special Committee of the Institute has investigated the problem of its treatment, and has shown that if it be roasted at a carefully-controlled temperature, potassium sulphate is rendered soluble and the alumina is left in a form suitable for use in the manufacture of metallic aluminium. But the economic utilization of alunite obviously depends, after technical difficulties have been overcome, on having a market available for both products, and at present no aluminium is made in Australia.

It is not surprising, then, that comparatively little use has so far been made of the Australian deposits, though in America large quantities of potash have been obtained from alunite during the past two or three years.

4. *Flue Dust from Blast Furnaces and Cement Works.*—Investigations were made and analyses carried out on these waste products, but in every case it soon became apparent that the iron ores and clays used in the Australian industries were much freer from potash than those used in England and America, and the flue dusts produced here rarely average more than 2 or 3 per cent., as compared with 5 to 10 per cent. in other countries, where they are worked as a profitable source of potash salts. In some cases, indeed, special potash-bearing ores and clays were introduced to enable the potash to be extracted.

5. *Coal Ashes.*—Again the same story holds good, for the ashes of Australian coals rarely contain more than ½ to 1 per cent. of potash. In response to a request for advice as to their value as an agricultural fertiliser, analyses were recently made by the Institute on flue dusts obtained from the Electric Power Station at Richmond, where Newcastle and mixed Australian coals were used. The analyses shows that the total potash contents are only 0.05 per cent., and of this merely traces are soluble. These dusts are evidently worthless as a potash or phosphoric acid fertiliser, though their physical properties may give them some value for top dressing.

6. *Plant Ashes.*—Many plants have been suggested. A number of the eucalypts were examined by Baron von Mueller many years ago, and isolated analyses have been recorded from time to time. Usually they are low, the highest figures (about 10 per cent.) being obtained from the ashes of the leaves; and a proposal was considered for the working up of the residual leaves at eucalyptus oil distillation plants, but it is doubtful whether, taking into account the small quantities available, the potash recovered would pay for cost of collection and lixiviation of the ashes. Probably they can be most profitably employed as an agricultural fertiliser in their immediate locality so as to avoid high costs of transport.

The salt bush has been suggested, but it was found that this once abundant shrub is now too sparsely distributed to be of value, although its potash content is comparatively high (16 to 18 per cent.).

The prickly pear ash contains about 8 per cent of potash, but experiments on its extraction have apparently not been commercially successful.

The water hyacinth, that pest of Queensland rivers, has to be dredged and hauled ashore to get rid of it. Analyses carried out by the Institute show that its ashes contain about 11 per cent. of potash, and therefore it could be utilized as a fertiliser under favorable circumstances.

7. *Summary.*—In short, with the exception of alunite, Australia seems to be deficient in high-grade sources of potash, but many waste products are available, chiefly in the form of ashes, whose potash contents are moderately low, and which can probably be best utilized as an agricultural fertiliser.

In this connexion, it must be borne in mind that in Australia, at all events in the wheat-growing areas, the soil is already so well endowed with potash as to render any further addition an unprofitable extravagance, except for orchards and special crops.

FUTURE PROSPECTS.

The deposits in middle Germany, and particularly at Stassfurt, which gave the potash syndicate a world monopoly of potash, turned out nearly 1,200,000 tons in 1914, of which only 530,000 tons were allowed to be exported. But it is not generally known that enormous deposits also exist in Alsace, now under French control, and that when the machinery destroyed by the Germans during the war has been put into order, it will be possible to export from this source alone no less than 800,000 tons annually.

Doubtless, prices will be regulated, but most of the emergency sources of potash will have had their day. On the other hand, the world may confidently anticipate in the near future an abundant supply of these valuable salts, quite independent of German control.

In the meantime, it would appear that Germany is to be allowed to pay portion of her war indemnity in the form of Stassfurt salts; at all events, a shipload from there has this month arrived in Australia.

"In comparison with research work carried out in Scotland, where the subject has not received the attention which it deserves, the extensive arrangements which are made and encouragements which are given to experiment and investigation in Australia are gratifying and surprising. Pleasant also is the universal enthusiasm discovered in the directors of experiment stations, and, indeed, in all connected with the work of development. It appeared to us, however, that a considerable amount of overlapping was going on, that in general there was a want of co-ordination and co-operation, that the policy of allowing each State to attempt to attack the solution of each agricultural problem by itself was not the most economical. There are many problems which are common to the whole of Australia, or to the greater part of it, and it would appear that time and money would be saved by placing some of the work of research in the hands of a Federal Department. For example, every State is afflicted with various stock diseases. In Queensland, there is 'tick fever'; and in another, 'dry bible'; in another, there is 'coast disease'; and so on. A strong and well-equipped Federal Department would seem more likely to cope with such diseases than the weaker and less well-equipped States Departments. The prickly pear, again, is not a State monopoly, but may, through time, spread over most of the country; and here again is an argument for Federal control, which would not absorb or limit the energies of the State Departments, but concern itself with a broader and a wider field."

—From Report of the Scottish Commission quoted by Hon. L. E. Groom, M.P., in his second-reading speech on the Science and Industry Bill.

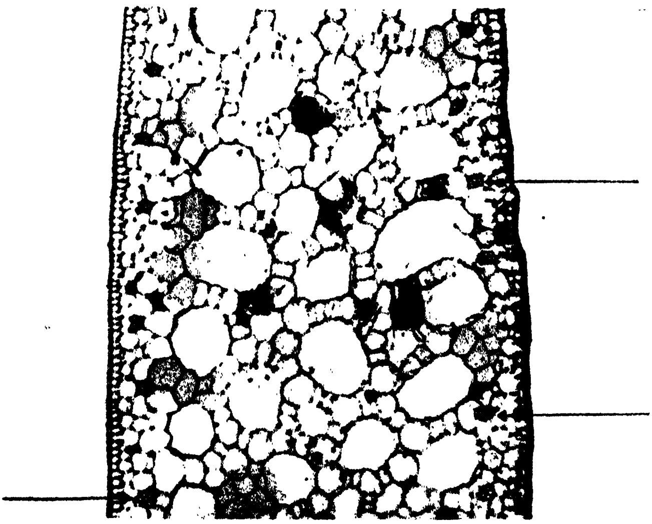
Posidonia Fibre.

A Valuable Raw Material.	Interesting Research : Work. :

By "BIOLOGIST."

An extensive Bulletin (No. 15, 60 pages and 20 plates) has just been issued by the Institute embodying the results of investigations on Posidonia Fibre by Professor John Read (Sydney University) and Henry G. Smith (Sydney Technological Museum).

Posidonia Fibre is derived from the fibrous portions of the leaves and stems of the submerged marine plant *Posidonia australis*, Hook, f.



PORTION OF A LEAF.

Posidonia australis, Hook, *f.* (*N.O. Naiadaceæ*).

Showing how the fibre bundles occur mostly below the epidermis in a regular row, with a few towards the centre of the aerenchyma. × 35.

(N.O. *Naiadaceæ*). This plant is apparently endemic in Australia, and occurs in immense deposits in the shallow coastal waters of Spencer's and St. Vincent's Gulfs. It has been recorded from the foreshores of Western Australia, Tasmania, and New South Wales, and probably extends round the whole continent, but is worked at two places only—(1) from Point Riley to Port Davis, a distance of 50 miles near the head of Spencer's Gulf; and (2) for a similar distance north of Port Adelaide to Port Wakefield. A large part of the deposit usually consists of the old stems with their bases covered with the filamentous remains of the old leaf sheaths. The main living leaves are long (1½ to 3 feet), and narrow (about ¼ inch) with rather numerous longitudinal

veins. They break off transversely, leaving the lower part sheathing the stem. The plant flowers and produces seed from which new plants are propagated, and these grow in the deposit of loose calcareous sand and ooze covering the old plants. When the plant dies the flesh parts are retted out and a small residue of fibre is left. This falls to the bottom and adds to the deposit already formed. How long these deposits have been forming it is impossible to say, but it has probably taken centuries, when we consider the thickness of the deposits and the amount of fibre that is produced from present living plants. The workable deposits are contained in flats which run out from the foreshore from 3 to 5 miles, and the fibre is found down to a depth of 7 feet or more. At low

POSIDONIA FIBRE.

As dredged up, washed, and prepared for market at Port Broughton, South Australia. One-sixth natural size.

tide these flats are exposed, and the surface is covered with the growth of living Posidonia mixed with other weeds. In working the deposit this top material is rejected, and the fibre is obtained from the underlying mass. The quantity of air-dried fibre obtained averages about 6 lbs. per cubic yard of deposit. This is a small amount, but it is easily recovered.

For raising the deposit from the seabed all the well known types of dredges have been tried—Priestman's crane with grab bucket, the bucket dredge, and the suction dredge. The best success has been achieved

with the last, which delivers the material in a large excess of water. The cleaning of the fibre has been one of the most difficult of all the problems met with in the development of this industry. In figures the problem was to separate 380 parts by weight of sand from 1 part of fibre at a cost not exceeding one penny per ton or cubic yard. Many machines have been built and experimented with, and many companies have expended thousands of pounds in attempts to exploit the material, which is estimated to cover a combined area of 240 square miles in the two gulfs, and estimated to produce 4,600,000 tons of fibre. The material as delivered by the dredge goes through various machines in

MASSES OF POSIDONIA FIBRE.

As found on the coast of Western Australia. The felted formation is brought about by the action of the waves. One-third natural size.

which the fibre is washed with sea water to get rid of shells and sand, rolled to drive out excess of water, and again washed with fresh water, using 25,000 gallons to the ton, and rolled so that the percentage of water left in the fibre is not more than 45. It is then dried by hot air at 205° F., and finally baled under great pressure (over 2 tons per square inch). The machines used are mostly of the standard wool washing and drying types.

The fibrous material in the mass is pale brown in colour, but varies somewhat from brown to white. Although called fibres, each filament is really a complex aggregate or bundle of "intimate fibres" just as a piece of string is composed of a number of strands each of which is again composed of individuals.

The fibre bundles measure up to 8 or 9 inches in length. These bundles are composed of ordinary wood fibres, and are true vascular bundles. It is only the bundles of the leaf base and stem that remain for collection. The individual fibres are attached to each other throughout their whole length in the bundle, long and short ones being arranged indiscriminately. The bundle has a striated appearance, due to the lines of the individual fibres.

The individual fibres are long, and spindle-shaped, with tapering awl-shaped ends. There is a wide lumen, and the walls are thin. The walls possess characteristic pits in double or single rows, mostly obliquely placed. There are swellings on the dorsal surfaces, averaging 4 to 6 per fibre. The fibre ranges from 0.7 to 2.0 mm. in length, and about 0.01 mm. in diameter. (Cotton fibre 20 — 40 mm. $\times$ .012 — .037 mm.)

The subject-matter is divided into four main divisions, which deal with the fibre from a Botanical, Structural and Physical, and Chemical point of view, as well as its properties and qualities as a textile fibre. The sectional headings under these divisions will give a bird's-eye view of the comprehensive nature of the research work involved. Under Structural and Physical characteristics we find:—The dimensions and structure of the natural and prepared fibres; tensile strength, elasticity, and flexibility; specific gravity. Under the Chemical section there are:—Moisture determinations; ash analyses; decomposition by heat; cold and hot water washing; alkaline hydrolysis; acid purification; mercerization.

Posidonia cellulose is then treated in some detail:—The yield, chemical properties, varieties, and the value as a paper-making material. It would appear that this cellulose differs from that derived from woods and lignified tissues, and inclines more to the straws and esparto, though readily distinguished from these. The material is quite suitable for making printing paper and the lower grades of writing paper provided certain economic conditions could be fulfilled, viz.:—(1) The cost of production of the fibre would have to be reduced to £4 per ton; and (2) a cheap supply of chlorine provided, to make use of the Kellner electrolytic process for isolating the cellulose. The yield is approximately 55 per cent.

Following this is an account of the chemical nature of the fibre and its use after nitration, for the preparation of explosives. As regards the yield, it differs markedly from jute, and exhibits a similarity to wood.

The experiments indicate that it is not regarded as suitable for large-scale production of explosives.

The dyeing properties are given for the various dyes used for wool and cotton. The best results are derived from the "acid violets," whilst the "substantive cotton" and the "sulphide" dyes are unsuitable.

The section on Posidonia Fibre as a textile material gives some interesting details of the increasing use of South Australian fibre as a

material for cloth making, producing coarse and weak fabrics, and also for mixing with wool in the preparation of lower-grade blankets. Just prior to the war Germany had been using about 8,000 tons a year.

The physical properties of the ultimate filament are described, and all the details are particularly relevant in deciding whether the individuality of the fibre fits it for any specific purpose. The results here agree with the chemical characteristics in proving that the fibre is more suitable for paper-making than for any other purpose. In resistance to chemical and bacterial influences, and in the amount of extension under strain, it shows superiority to several of the usual textile fibres; but in most other respects it shows great inferiority, *e.g.*, shortness, coarseness, and irregularity of staple; complex structure of filament, unsuitable dimensions, and chemical character of the ultimate fibres.

Of the characteristics under review it is conceivable that by appropriate artificial treatment, the physical properties might be improved within limits. With this end in view, many experiments were carried out, of which details are supplied, to produce a fibre suitable for textile purposes. A marked degree of success has been attained. The main physical defect of the crude commercial fibre is its brittleness, though the tensile strength is also somewhat low. It seems possible, from the experimental results so far, to bring about an increase of about 25 per cent. in the tensile strength.

The elasticity has been much increased by artificial treatment, and simple methods of treatment have been discovered whereby a remarkable degree of flexibility may be imparted to the fibre, enabling the filament to be knotted repeatedly with ease.

A Bibliography of 66 references is added.

The Making and Improvement of Wheats.

By HUGH PYE.*

(*Continued from page* 210.)

(II.)

IT has been noted previously that wheats suitable for the dry areas with a 10-in. rainfall need to be those that mature early, tiller very moderately, have little flag development, and short to medium length straw.

Some interesting experiments were carried out by Mr. A. E. V. Richardson relative to the transpiration ratio for some of the wheats, and published in the Victorian Agricultural Department's journal.

Yandilla King needed 209 tons of water to each ton of dry matter, whilst Huguenot needed 243 tons of water.

When it came to the production of grain, Yandilla King used 660 tons of water, or a 6.4-in. rainfall. Federation required 750 tons, Huguenot 1,081 tons, and Kubanka 1,188 tons. In countries possessing a more moist climate there would be a variation in this respect.

One of the reasons the plant-breeder uses the varieties obtained from the older dry countries of the world is, that the quality of drought resistance has been implanted after generations of growth in them. By utilizing these varieties, the plant-breeder "gets there" quickly, and all he has to do is to develop this quality, and combine it with other qualities suiting the environment and methods of harvesting.

It may be detrimental to create a multiplicity of varieties, but Australia is a new country, and we must experiment, even using each State as a huge experimental system; for, after all, the test of a wheat is not only what it yields at the experimental station, but its average yield over wide areas. A variety that has excelled soon supplants a less prolific variety.

Knowing from a wide correspondence throughout the Commonwealth that the farmer of to-day is appreciating more the work of the practical scientist, and calling him to his aid in solving his difficulties, it is right that farmers should be anxious to get a deeper insight into the part plant-breeding is doing for the whole agricultural community.

The cost of living, higher taxation, the increased cost of production, the decrease in the virgin wealth of the soil, the necessity of giving a higher education to his children to meet the strenuous future, the pressure due to custom in regard to social amenities in keeping his family contented on the farm, all are having a far-reaching effect in spurring him on, and wresting from his farm greater productivity and increased wealth.

* Cerealist, Dookie Agricultural College.

The Work of the Plant-Breeder with other Plants.

The horticulturist, the vegetable gardener, and the florist are equally intent in the work of the plant-breeder, so that by his methods they may learn to produce seed true to name, and so augment their profits by specializing in seed production for those who are indifferent, or are less favorably situated. The fine fruits now grown, the many excellent vegetables, the splendid wealth of flowers which grace our gardens, the high sugar-content beets and other roots, and the numerous selection of high-class potatoes, are the result of keen selection and cross-fertilization. The importance of this work is every year impressing itself on growers. It has become so important and necessary, that it has entered into the scope of work of highly trained scientists who specialize in it.

Sir William Crook's Augury.

To-day my mission is to appeal to the intelligent wheat-growers of the Commonwealth, and to imbue them with the national importance of producing grain true to name, and especially adapted to their environment. Not twenty years ago, a distinguished scientist stated that, at the rate the world was using up the great natural storehouses of plant food, it would only be a matter of comparatively few years before there would not be sufficient wheat to feed the increasing number of bread consumers. The declining wheat yields in some countries made this augury set men thinking. One set of men confined their attention to unravel the mysteries of the soil, and devoted their energies to study how it should be treated in order that the maximum yields should be obtained with a minimum loss of plant food and cost. Another set of men turned their attention to the creation of new varieties that had more stamina, greater yielding powers, and better food-supplying capabilities. Not only had these varieties need to have inherent in them such qualities, but they must also have implanted in them the practical virtues to make their harvesting economical. They should also have the power to resist the force of the elements, also drought and disease. The combined efforts of these workers have allayed alarm. Conspicuous, too, among the world's workers are the great inventors of harvesting and tillage machinery, who make it possible to cultivate, to sow, and to harvest profitably in remote parts, where the natural conditions are more or less antagonistic. Every decade sees some new improvement in agricultural machinery, and crops that at one time could not be harvested are not now altogether lost.

Scientists at Work.

The biologist who studies the functions of the members of the unseen world within the soil and the part each plays; the labours of the chemist, physicist, and plant-breeder; and, above all, the hearty co-operation of farmers in these progressive movements, make it improbable that, as regards wheat, there is any likelihood of there being, even in the distant future, insufficient of it for the world's needs. Again, when the progress made in the development of new varieties of other grains and seeds is considered, it is evident that the future of the world's food supplies will be more varied and better as regards vegetable productions.

The Problems of the World's Wheat Supply in its Relation to Australia.

The problem of the world's wheat supply is of absorbing interest to Australians, as there are yet millions of acres with a 10 to 20 inch rainfall still untouched by the plough, which in all probability will, at some future time, be one of the granaries of the world. Australia's output of wheat is increasing. In 1901, it was a little over 48⅓ million bushels; in 1916 it increased to over 179½ million bushels. This increase, though mainly due to the increasing area put under wheat, is also partly due to growing of selected varieties suitable to the soil and climate, and to the adoption of better methods of cultivation and better cropping rotations.

Not the least cause of this marked improvement of the yields is due to the efforts of the plant breeder in giving to the growers, as a result of keen selection, prolific varieties suitable to the environment.

By patient work and study, he crosses and re-crosses seedlings, implants in some of the progeny the qualities needed for a particular soil and climate, and of these, prolificacy, a quality depending on a complexity of conditions, must stand in the forefront; and where diseases are likely to occur, he must produce varieties that can resist their attacks, especially those resistant to rust.

Wheats Desirable for the more Arid Districts.

As the wheat-growing areas extend to the dry belts of only a 10-in. rainfall, drought resistance and rapid maturity must be inherent qualities of the varieties grown. Fortunately, the rainfall of these areas occurs during winter and spring; whereas in some of the other new countries, the rainfall occurs in the summer, making it apparently impossible to grow wheat successfully. Still, the limitations of the work of the plant-breeder have not yet been reached, and it may yet be possible to develop wheat so highly resistant to rust that wheat may be profitably grown in them. The plant-brèeder, by crossing different varieties, breaks the types, and introduces new types in the progeny. The crossing of wheats is a simple operation that can be done by a child. The great work in wheat breeding is to so arrange the pedigree that the qualities desired may be implanted in the individual plants of the progeny, and that they will remain fixed, or reproduce themselves in future generations.

Selection Varieties.

Keen selection is essential; in fact, during the earlier history of wheat improvement, it was by patient selection that many valuable varieties came into use. This obtains to-day; but the work of the plant-breeder in giving to the world new types has made it possible to select varieties suitable to almost every country; and from among these varieties, strains much better and more suitable may, with patient selection, be evolved. The first consideration, however, is to grow the variety suitable to the climate, otherwise it would likely take a half century to evolve a variety that will give profitable returns. By crossing, the object is attained in much less time; even then it takes some years to select from the variety strains within it that are the most

prolific, and possess to a high degree the proper harvesting qualities. This latter is quite within the scope of work of the interested wheat-grower, but he should test each selected plant in its own plot, and not mix the strains when sowing the seed. At harvest, he compares the yields and accumulates the seed of the strain best suiting his environment. This work should be carried on year by year. It is done at the College with all the standard varieties, hence the reason, when the seed bought by farmers is tested against their own unselected seed, it almost invariably gives the higher yield. Every farmer should induce his sons to take up the work of seed selection if he has not the inclination or time to carry it out himself. It means increased wealth, not only to himself, but also to the nation, as his name for good, pure, and healthy seed would soon be widely known in his and the surrounding districts, with the result that his efforts become of far-reaching importance.

The Unscientific Method of Buying Wheat.

The time will surely come when such a basis as the "Fair Average Quality" will be too wide, and the purest, cleanest, and healthiest plump wheat alone will command the highest price. This is as it should be, and would be the greatest incentive to the growing of clean crops of pure grain. Farmers would then select and keep selecting, just as the studmaster has for his motto "Breed up, and still breed up." There is nothing to prevent the wheat-grower doing likewise with his seed. Select and still select, until a variety is produced which will make the original stock pale with insignificance. It becomes a "has been," like so many of the old standard varieties whose names are almost forgotten. There is no magic in the transformation. It is simply intelligence brought to bear in a practical way. To do this, a scientific education is not necessary, but scientific thoughts are, and bring to bear applied intelligence.

The Importance of a Scientific Spirit among Wheat-growers.

The scientific farmer will likely arrive earlier, since he may know why the variety is not altogether a success. For instance, knowing the climate and rainfall, it will at once occur to him in the dry wheat belt that a moderate tillering plant of early maturity will give a better return than a strain which tillers much, and thus he would strive to select strains which will not waste their energies in throwing up stems which they cannot properly mature. He sows just sufficient seed per acre not to give too much space to induce tillering, but just sufficient for each individual plant to thoroughly mature a few stems that the soil and rainfall allow.

(To be concluded.)

Australian Leather.

Its Quality Defended.

By R. J. ANDERSON.

(In the previous number of *Science and Industry*, there appeared a report furnished by Mr. Coombs, of the Sydney Technical College, to the Institute of Science and Industry, upon some defects in Australian leather. Mr. Coombs' report was forwarded by the Advisory Council to the Commonwealth Leather Committee for comment. The deputy chairman of that body, Mr. R. J. Anderson, then* reported as follows) :—

The report herein submitted by Mr. F. A. Coombs, Tanning Department, Technical School, Sydney, and referred by the Advisory Council of Science and Industry, has been duly considered by this Board.

The subject may rightly be divided into two parts—

(*a*) Leather for Australian use.

(*b*) Leather for export.

In connexion with the former, Mr. Coombs states that—

(1) Boot manufacturers require a cheap and inferior leather;

(2) If the people were keen and could detect it, the boot manufacturer would be compelled to use leather of a higher standard.

(3) As the people do not demand a good sole leather, the standard must necessarily be low.

(4) He does not wish to give the impression that all Australian leather is not up to a desirable standard.

(5) But he does not hesitate to say that a large proportion is inferior as regards quality.

(6) The production of this inferior leather is probably due to the fact that there is a big demand for it.

(7) To produce this cheap leather, the tanner reduces the time for the tanning process, and fills up the leather with extract and glucose.

The majority of these points cannot be conceded. The public demand generally is for good and reliable footwear. Boot manufacturers are fully alive to this fact, and, in consequence, are very keen on securing the highest standard of leather.

From information furnished this Board, it is beyond dispute that tanners of high-grade leather cannot nearly satisfy the demands for such leathers, and in a number of instances such tanners are making considerable additions to their plant to enable supplies being given.

One thing is certain, namely, that of all the hides produced in Australia the best are tanned in Australia, and when converted into leather the best of same, absolutely, is used in Australia.

Admittedly there is—as with all other commodities—a demand by a certain section of the public for low-priced footwear, which cannot be other than of inferior quality.

Mr. Coombs also states that, in his opinion—

> "The Federal Government could have done a lot to improve the quality of local leather by adopting a certain standard for military sole leather,"

and, later, submits certain suggestions relative thereto.

The suggestions put forward by Mr. Coombs are on right lines, but these, practically, have already been adopted by the Department of Defence.

The authorities have been fully alive to the importance of producing the highest standard military boot. In connexion with large contracts for same now being executed, the specifications provide—

(1) "That the soles of the boots are to be cut from the best Australian tanned crop, and to be equal in substance and quality to those in the sealed patterns" (which are recognised to be of the highest standard).

* This reply was written on 12th September, 1918.

(2) "That all leather used in making up the boots to be of Australian manufacture, free from flaws, of correct colour, and not inferior to that in the sealed pattern in any respect. It is to be free from impurity, weighting, or other matter not required in the preparation of leather of the best quality. Provided that the following shall not be deemed to be loading substances:—

"In the case of sole leather, glucose and sugar to the extent of not more than 3 per cent. taken together, and fats and oils to the extent of not more than 5 per cent. taken together."

(3) That the use of sulphuric acid in the manufacture or preparation of the leather is strictly prohibited.

(4) All sole leather to be well and faithfully rolled.

It will thus be seen that the Department has set a very high standard as to the leather to be used in the manufacture of military boots.

On the question of the use of glucose or sugar in leather, opinions vary somewhat. Where leather is highly tanned, and taken from liquors of high strength of tannic acid, it must of necessity have some dressing applied. If glucose or sugar to the extent of not more than 3 per cent. be used, it certainly is not injurious. The assertion by Mr. Coombs that—

"Glucose or sugar cannot be used in small quantities as a finishing agent,"

cannot for a moment be accepted. They certainly can, and, moreover, are being so used.

That some tanners use much larger quantities of glucose and sugar is recognised, but there is no necessity or warrant for it. Strange to say, that whilst the Commerce Act (a Federal measure) protects users of Australian leather in other parts of the world by prohibiting the export of leather from Australia if it contains above 10 per cent. of these materials taken together, there is, in some States, no such legislative protection afforded Australian users of leather.

If legislation (both Federal and State) were enacted, and provision embodied in the measures similar to those set out in the specifications relating to military leathers, above referred to, it would be a distinct advance.

Mr. Coombs' reference to the use of extracts is in order. No exception, however, can be taken to the use of extracts which, throughout the world, are coming into favour. The objection is in the abuse of their usage by forcing same by use of drums into leather of comparatively short tannage. In such a way satisfactory results so far as yield of weight is concerned are obtained; but for producing a permanently close, solid, and superior leather the old method of long tannage in pits stands alone.

Coming to the second part of the subject, that of the export leather, Mr. Coombs refers to—

"the large amount of Australian leather which, for unknown reasons, could not be exported from Australia";

and, later, after expressing the opinion that the bulk of the leather both made and used in Australia is of inferior quality, goes on to say—

"There is no doubt that a large proportion of this inferior leather has been exported to England, and those men who are advising the British Government as to the most suitable leather for military boots certainly know that this particular leather will not give desirable results, especially in a wet climate. There is no doubt in my mind that the British leather experts know the quality of this leather, and if they condemn it for military purposes, they could hardly allow it to be used for civilian boots. Now, if my statements are correct, it is not a fair proposition for us to expect the people in a wet climate like England and France to wear this leather on the soles of their boots."

Unfortunately, it is true that there are large accumulations of Australian surplus leather awaiting shipment to the United Kingdom, but, that this is due to its inferior quality, as presumed by Mr. Coombs, and so declared by certain British authorities, is not borne out by fact. There are other reasons.

It has never been contended that Australian surplus leather is suitable for British military purposes; it is too light. The heaviest and best grades produced in Australia are prohibited export from Australia, as they are urgently needed here for military and certain civilian purposes. What leather is exported is admittedly light in substance, but for actual quality and character of tannage a

fair percentage is precisely identical with the heaviest grades retained here. The argument, therefore—

> "that if the British experts condemn it for military purposes they could hardly allow it to be used for civilian boots"

is not sound reasoning.

Australian leather has at all times enjoyed a ready sale on the London market, and the quality to-day is fully equal to that shipped in the past. Evidences are not wanting that there, at the present time, it is keenly sought after. The prices realized for the last shipment in October, 1917, is undoubted and convincing evidence as to its quality and worth.

Opinions are firmly held that there are influences at work to not only keep Australian leather out of the United Kingdom, but to draw as largely as circumstances will permit on Australian raw hides. There is certainly good ground for such belief.

It is beyond dispute that, although light in substance, some of the highest quality leather has been lying here awaiting export, ever since the British embargo on leather was imposed eighteen months back, and, although cables have been despatched intimating that—if on account of shortage of shipping space or for any other reason high grade leathers only are wanted at Home—the Commonwealth Government is willing to co-operate in any way desired to insure that only best tannages are shipped. Notwithstanding this Commonwealth guarantee authority cannot be obtained to ship one ounce of leather.

On the other hand, many thousands of hides—the great bulk of which are either fearfully ticky, damaged, or bulls—have been, and are being, regularly shipped. From such hides it is an utter impossibility to produce first-quality leather, yet, forsooth, these hides are being readily accepted, whilst choice leather is strictly forbidden.

Australia holds a record of which any country may justly be proud for the high standard of leather equipment supplied to her troops in all the theatres of war, including France, where the weather conditions are wet and sloppy. Large repeat orders for boots now being executed for the Australian Imperial Force in England and France emphasize this fact; yet is it seriously contended that leather of precisely the same tannages is not suitable for ordinary civilian use in the United Kingdom.

Mr. Coombs' conclusions that—

> "if the Australian tanning industry had been thoroughly organized at the beginning of the war, Australia would now have been producing and exporting all classes of military leathers, with the single exception of light sole leather for a wet climate,"

are not well founded. It certainly so happens that large orders for military leathers on account of the Indian Government have from time to time been placed with Australian tanners by the Commonwealth Government, and that a repeat order—double the size of those in the past—is now being executed; but to what other country could military leathers be supplied? That such leathers would be accepted in Great Britain cannot, under the circumstances, be imagined.

It has long been established—even before the war—that highly tanned, well-filled, and prime Australian sole leather was not keenly wanted in England; what was required was a clear, bright-coloured, lightly-tanned and light-weighing leather, that would lend itself to being "retanned." Such leather at all times enjoyed a strong demand at highest rates. Needless to say, when so treated its weight would be considerably increased. In this connexion, if English sole leather be examined, it will be found that in its manufacture a fair amount of dressing has been used.

In conclusion, this Board recognises that, in respect to a number of Australian productions of leather, there is room for improvement, and to such end legislation on the lines above referred to—relating to military leathers—would be of material assistance.

On the other hand, it is recognised that quite a number of tanners are live, progressive men, and are ever-anxious to keep fully abreast of the times in producing leather of the highest quality

The one stumbling-block now even to the maintenance of the normal production of leather in Australia—apart from the desirable expansion and development of the industry—is the refusal of the British authorities to sanction shipping space being provided for our surplus leather. All that this Board urges in respect of this is that Australian tanners be given a "fair deal," and there will be no cause for complaint.

Personal.

In view of the death of Dr. Gellatly, and pending the passage of the Bill for the permanent establishment of the Institute of Science and Industry, the Minister for Trade and Customs (the Hon. W. Massy Greene, M.P.) has appointed Professor D. Orme Masson, C.B.E., F.R.S., Chairman of the Executive Committee of the Advisory Council, and Mr. Gerald Lightfoot, M.A., Chief Executive Officer of the Institute. Mr. E. N. Robinson will act as Secretary.

Mr. F. W. Reid, B.Sc., secretary of the South Australian Committee of the Advisory Council of Science and Industry, and Principal of the Adelaide School of Mines, together with Dr. Fenner, Superintendent of Technical Education of South Australia, and Mr. L. Laybourne Smith, B.E., F.S.A.I.A., recently visited Victoria to make inquiries into the general arrangement and equipment of technical schools in this State. In consequence of a gift of £5,000 by Sir Langdon Bonython, President of the South Australian School of Mines, the South Australian Government has agreed to supplement that amount to build and equip a Technical High School for Adelaide. Dr. Fenner, and Messrs. Reid and Laybourne Smith have been appointed a committee to advise upon the plans, curriculum, equipment, &c.

At the recent Conference of Architects, held in Sydney, Mr. L. Laybourne Smith was elected President of the Federal Institute of Architects. For many years he was Principal of the South Australian School of Mines. He is Secretary of the Institute of Architects of South Australia, and is practising his profession in that State.

Dr. J. L. Glasson, who has done excellent work in relation to the application of hydro-electric power to industries, has resigned his position as lecturer in physics in the University of Tasmania. He intends to go to England and Europe to study some of the latest developments of science.

Mr. R. Lockhart Jack, Assistant Government Geologist, South Australia, has published a bulletin dealing in a comprehensive manner with the phosphate deposits of South Australia. Mr. Jack says that South Australia is fortunate in having supplies of phosphate rock scattered over a wide area, which, although not equal to the imported material, can be made available to supply part of the demand in Australia. The total output of phosphate rock in South Australia to the end of 1918 was 89,000 tons, valued at £96,000.

Mr. D. Avery, of Messrs. Avery and Anderson, consulting chemists, Melbourne, has been appointed a member of the Institute's Standing Committee on Chemicals.

Mr. E. G. Scriven, Under-Secretary, Department of Agriculture and Stock, Brisbane, has been on a visit to Melbourne, and was present at a special meeting of the Executive Committee of the Institute to discuss the question of cotton cultivation in Australia.

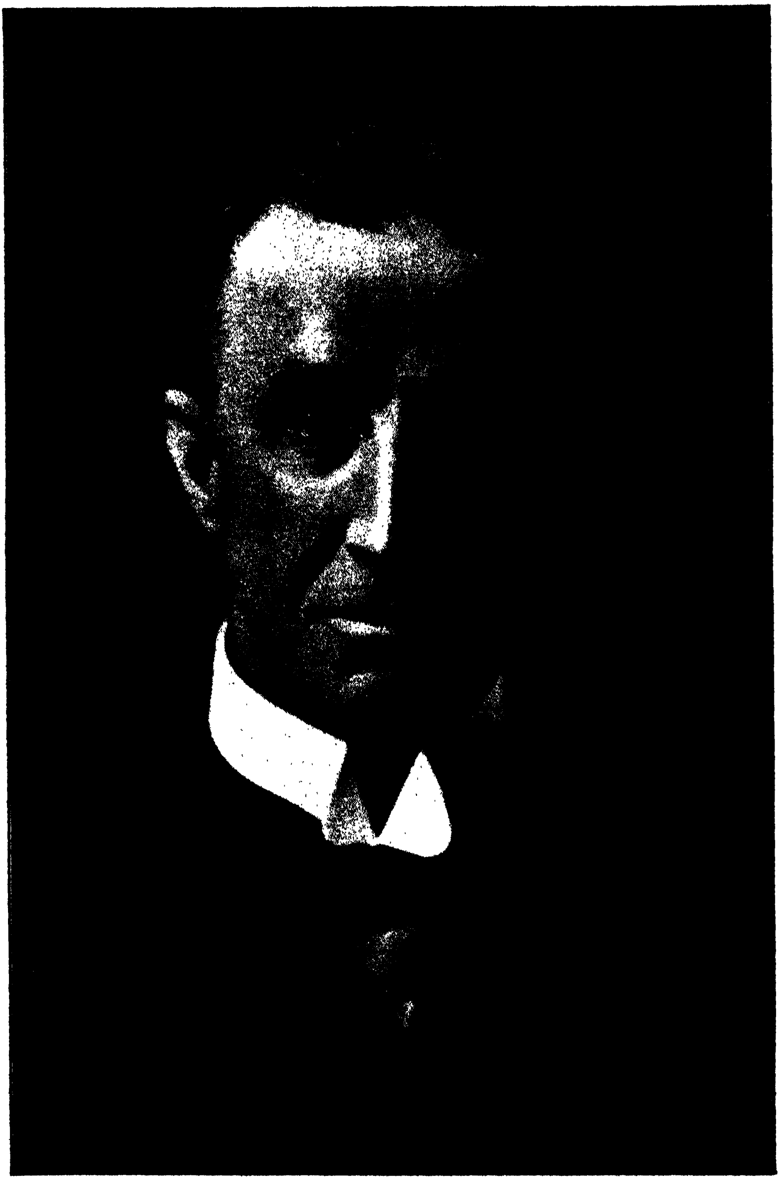
Reviews.

Boiler Chemistry and Feed Water Supplies, by J. H. Paul, B.Sc., F.I.C., London, Longmans Green & Co., 1919. In the preface to this book the author states that boiler chemistry has not received the attention it merits. A more or less perfunctory analysis of feed water, made with a view of dealing with the scale-forming constituents, is all that has hitherto been generally considered necessary for boiler work. Little or no investigation has been made, of the innumerable reactions that take place when natural waters are heated to some 400 deg. F. under a pressure of fifteen to twenty atmospheres. Under these conditions new combinations are brought about and unthought-of reactions take place. A modern boiler is not merely a basin in which liquid water is converted into gas, but a receptacle for the mineral contained, in greater or less quantities, in all natural waters even when softened. The boiler is in reality an autoclave in which chemical solutions are concentrated and partially evaporated at high temperatures and pressures, and should be looked upon as a chemical factory in which various chemicals are produced during the conversion of ordinary water from an initial temperature of, say, 60 deg. F. into steam often highly superheated. Some of these reactions affect the steaming capacity of the boiler, and others affect the metal of which it is constructed. If these reactions are not properly understood and properly controlled, much damage may be done to the metal itself, even if that damage be not sufficient to cause explosion or render the boiler useless for steam-raising purposes. An account is given in the book of some of these reactions, and attention is called to the conspicuous part played by carbonic acid in boiler chemistry.

Chemistry has improved the physical character of industrial iron and steel, and rendered possible the use of the high pressures now employed in steam boilers, and an acquaintance with the reactions which take place in a boiler under modern working conditions will enable steam users to preserve their boilers from those evils which are roughly summed up in the expression "scale and corrosion."

Many of the chemical reactions described in the book have been gathered from a long practical experience with high-pressure boilers working under varied circumstances and conditions, and the analyses given in the text are original analyses made by the author in the course of a somewhat extended practice.

So far as possible, technical language and expressions have been avoided. The facts stated and the conclusions drawn are described in the language of every-day life, so that those without more than a very limited acquaintance with chemistry may be able to understand and appreciate the results, and a chapter has been added explaining and illustrating such technical expressions as it has been found necessary to use.



Mr. A. B. PIDDINGTON, K.C.
Chief Inter-State Commissioner and a Member of the Executive Committee of the Institute of Science and Industry.
(See Page 443.)

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

Neither the Directorate of the Institute nor the editor takes any responsibility for views expressed by contributors under their own names.

Articles intended for publication must be in the hands of the editor at least one month before publishing date.

No responsibility can be taken for the return of proffered MSS., though every effort will be made to do so where the contribution offered is regarded as unsuitable.

Besides articles, letters to the editor and short paragraphs of scientific interest, as well as personal notes regarding scientists, will be acceptable.

All subscriptions are payable in advance.

Changes in advertisements must be notified at least fifteen days before publishing day.

Articles may be freely reprinted, provided due acknowledgment is made of their source.

Science, the Press, and the Public.

AT the recent meeting of the American Association for the Advancement of Science, a paper was read on the subject of "The Press as an Intermediary between the Investigator and the Public." Not many years ago it is doubtful whether there would have been any unanimous or immediate assent to the doctrine that any merely popular intermediary between the scientific investigator and the public was even desirable. During recent years, however, the widespread movement for the application of science to industry has brought about a radical change of feeling on the part of industrial research workers to the whole question of publicity, and it is now recognised that the sympathy and support of the public press will play an increasingly important part in promoting the success of that movement. By this it is not intended to suggest that the press should support any particular scheme of organization for the application of science to industry, but that by opening its columns regularly for the publication of articles relating to scientific matters, the press can go far towards imbuing the people with that scientific spirit without which no nation can achieve eminence or success of the first order. As Mr. Hughes pointed out at the initial Conference in 1916, when the scheme for the Institute was launched, we must get the people

of Australia to appreciate science, which has been a recluse, so that they desire it as a friend. This can best be done by letting the people know that science is both practical and profitable.

In the past there has been aloofness on the part both of the scientist and the public, and for this neither side has been guiltless. Often the research investigator, engrossed in his work, has inherited the aloofness of a professional guild, and often, even if not influenced by that feeling, he has had reason enough to remain aloof from the public. For, if his discoveries were of immediate practical value, he was ready to leave it to others to advertise them in due time. If they merely opened wider the gates of knowledge, the public was little interested, and the time for its enlightenment would come later, when the results of the research published in a scientific memoir or journal were boiled down to a sentence or a footnote in elementary text-books. From the researcher's point of view, it seemed useless to endeavour to give the public the information it ought to have, and worse than useless to give it what it appeared to want.

The public, on its side, has largely failed to appreciate the scientist. Individually, it often regards him as an impractical dreamer, lacking in those qualities which go to make the successful business man—an impressive personality, a decisive manner, and executive ability. Then there is the illusion about "book-learning." Since most of the knowledge with which the public is familiar is derived from books, it is assumed that higher learning is also derived from the study of books, and that a "professor" is a dry-as-dust person who has stuffed his brain with many books. The layman has failed to realize that to-day science is the most practical thing in the world, and that it constitutes, perhaps, the most effective agency for the comprehensive and systematic development of a country's resources. Our Agricultural Departments have to some extent succeeded in breaking down the barrier between the scientist and the layman. This has been possible largely because the farmer now realizes that the agricultural scientist is a practical and not merely a book-learned man, and that he finds out things by experiment in the same way as other people do, only more systematically and more exactly. It is true that the war has brought to the average man a general, but vague, realization of the tremendous importance of science and its application in actual life. Yet the same average man is not provided with literature which is readily accessible and easily understood, and from which he can get a scientific view of things.

Now, the Australian citizen is an intelligent and thoughtful person, and it can hardly be doubted that if the facts were placed before him in a way he could easily comprehend, he would be interested to learn how closely science affects him in practically all the commodities and

materials he uses in his daily life. Take, for example, the one subject of the chemistry of cellulose, with its wonderful actualities and almost bewildering possibilities. This may not sound interesting, but it can be made interesting, and it is, in fact, a subject of the most direct and practical importance to every man, woman, and child. Cellulose is Nature's great structural material, and without it the earth would be bare of vegetation, an arid waste, without grass, or trees, or flowers. There would be no agriculture, no textiles, no papers, and no picture-theatre shows! Thus, although cellulose vitally concerns the average man in a host of things which he uses, or with which he comes into contact in his daily life, he has probably never had the opportunity of learning anything about it. The same thing is true in regard to practically all subjects of scientific research. The average man does not, in fact, realize that there is not a business, from shoe-blacking to banking, which is not really based on the application of the results of scientific research.

The matter of imbuing the public with an appreciation of the actualities and possibilities of scientific research and the removal of the lack of sympathy and understanding between the scientist and the public are of immense importance to our Australian Democracy. Not only is our future as a nation largely dependent on the application of science to industry, but our most grievous lack, as a people, is our ignoring of experts and our fiction that the merely practical man is the man who is fit for the job. Germany did, at all events, teach us one lesson which we must not permit the war to unteach us, that is the lesson of valuing and trusting the expert. And, if we fail to learn that lesson, we may ultimately inflict on the Commonwealth an even greater material damage than that which we suffered through German arms. It is, therefore, the duty of the Australian expert, even at the cost of some repugnant self-exploitation, to make himself understood and respected by the Democracy. This he cannot do in the laboratory and the scientific journals alone. He must make himself known to the public, and for this purpose the daily press is indispensable. Any scientific facts, or anything calculated to imbue the layman with the scientific spirit, that can be got into the daily newspaper will reach further than it can do in any other way.

In America, science has been regarded as a three-legged stool, of which one leg stands for teaching, the second for research, and the third for extension, or publicity. If science, then, is to stand firm and strong, it is necessary that the publicity side should be developed equally with the other phases, and in America this has been done. Many of the State Universities have established extension divisions, which have as their specific work the duty of acting as a medium between

scientific workers on the one hand and the people on the other, and of disseminating the results of investigation and research among the people in a way they can understand. They bring before the people in a form which they can grasp and utilize the latest facts concerning food, hygiene, natural resources, agriculture and dairy processes, household interests and domestic science, engineering and manufacturing processes, discoveries affecting the prevention and cure of disease, economic questions, and many other questions affecting the social, educational, and political environment of the individual. In short, they gather the stores of contemporary information from the expert and the research worker, and pass them on in simple and practical form. The general appreciation, thus engendered, of the practical value of scientific research, and of the necessity for scientific guidance, is in no small degree responsible for the wonderful industrial progress of America.

It is not suggested that in Australia we can yet embark upon any such comprehensive schemes as those adopted in America for the dissemination of knowledge of scientific methods. Much can, however, be done in this direction with practically no additional expenditure of money, provided the sympathy and support of both the Australian press and Australian scientists are forthcoming. The Saturday and Sunday editions of our daily newspapers would afford an admirable means for the dissemination of scientific information. The Australian scientist must, however, present his facts in such a way that they are readily understood by the non-scientific reader, and that they will be acceptable for publication. If he will realize the primary importance of the picturesque, and the necessity for stimulating human interest, he can do much to unlock the door which has in the past largely kept science out of the most widely circulated of all publications. It is hoped that the Institute will be able to act as the medium through which this important work can be accomplished.

—G. L.

"Let us arouse the people of our country to the wonderful possibilities of scientific discovery and to the responsibility to support it which rests upon them, and I am sure they will respond generously and effectively."

—Colonel J. J. Carty, Vice-president of the American Telephone and Telegraph Company.

EDITORIAL

SUPPORT FOR THE INSTITUTE.

Keen disappointment will be felt that the Bill for the permanent establishment of the Institute of Science and Industry could not be dealt with by the recent Parliament, and must await final consideration until the next Parliament assembles. Scientific and industrial organizations throughout Australia were looking forward with eagerness to the passage of the Bill, so that industry might be given the fullest assistance by trained scientists, and many obstacles to our industrial development removed. In the meantime, the Commonwealth Government will still retain the services of the Advisory Council, and the investigations which have been commenced will be continued. There is an important programme of work for the coming twelve months, and it is expected that, in addition to the various problems now under consideration, a commencement will shortly be made with the prickly pear problem. In Sydney recently a meeting, which was attended by representatives of the Graziers' Association of New South Wales, the Sydney Chamber of Commerce, the New South Wales Chamber of Manufactures, Institute of Civil Engineers, Australian Industries Protection Board, Austral an Chemical Institute, Australian Aero Club, The Electrical Association of Australia, Engineering Association of New South Wales, Chemical Society of Technical College, Chamber of Agriculture, Society of Chemical Industry, Royal Society of New South Wales, University Chemical Society, Linnean Society of New South Wales, Master Builders' Association, Institute of Local Government Association, Master Process Engravers' Association, and the Wireless Institute, unanimously adopted the following resolution, "That this meeting of members of scientific and industrial societies urge upon the Federal Government the desirability of passing into law at an early date the Bill constituting the Commonwealth Institute of Science and Industry." That meeting reflected the feeling of kindred organizations in other States regarding the necessity of the early permanent foundation of the Institute.

BOXES FROM PAPER PULP.

Owing to the growing scarcity and fast-increasing price of timbers suitable for the manufacture of butter-boxes, the question of the utilization of an appropriate substitute is being widely discussed amongst exporters. Old straw, cornstalks, and similar waste products have suggested themselves to many persons as possible materials for conversion into strawboard, and apparently the view is largely held that the only difficulty to be overcome is that of chemical treatment. At the

request of the Primary Producers' Union of New South Wales, and of the Department of Agriculture, New South Wales, the Chemical Committee of the Institute of Science and Industry was recently asked to investigate the proposal; but it would appear from their report that many economic problems are involved, and that established trade practice must be considered in relation to the general inquiry. From a preliminary survey of the position, it appears that the cheapest raw material available in quantity in South-eastern Australia for making paper pulp is undoubtedly straw (wheaten or oaten). This usually costs from 30s. to 40s. per ton—little more than the cost of collection and cartage.

The Committee reported that, in attempting to utilize old straw, cornstalks, &c., the expensive treatment and the low yield of cellulose pulp have to be considered. It is doubtful if it would pay to collect for this purpose any material now discarded as rubbish. Assuming then that straw boiled with lime and beaten to a pulp is used, it might either be pressed into boards or cast directly into a one-piece box. Although a water or air proof package is not required for the carriage of butter, yet this straw-pulp box must be specially treated to make it adherent and strong enough, particularly when exposed to water. Strawboard, when wet, has also an objectionable smell. Probably these defects could be overcome by the addition of some binding and hardening material, such as paraffin wax, resin, soap, or waterglass, &c., which would reduce the porosity of the board. Obviously, odorous waterproofing varnishes, such as magramite and linseed oil, must be avoided.

Another consideration is the cost of the material. The pre-war cost of strawboard was less than £10 per ton, and it now sells for about £28. The elaborate and expensive machinery required for calendering the board is responsible for a large proportion of this cost, and would not be required for making pulp for butter-box construction. On the other hand, special moulds and presses would be required. A further reduction in cost is probably possible by incorporating sawdust (after special treatment), or other filling material, with the pulp. Such a mixture could be poured into suitable moulds like concrete. There are objections to a square-cornered box being cast in one piece, but, if the trade could be induced to pack butter in boxes of the present capacity, but made with rounded corners, a method of construction which might possibly be feasible suggests itself. The lid of the box could be made in the form of a round-cornered tray about 3 inches deep. It should fit nicely like the lid of an ordinary cardboard box, and could be secured in place by means of a glued strip of paper.

On account of the shape, they would be stronger than square-cornered boxes, and could, therefore, be made of thinner walls, and with a considerable saving of material. They would also pack economically without any re-organization of the present system of handling. While this appears to be the most promising method of utilizing straw pulp, it is obvious that much investigation is required before it could be adopted—investigation in the laboratory, with the assistance of some paper-mill machinery to determine the most suitable pulp—and experiments on the mechanical side to construct effective moulds, dies, and presses with

which to form and consolidate the boxes. With reference to the proposal recently before the Institute of Science and Industry for the establishment of a small and comparatively inexpensive paper-mill for experimental purposes, it may be mentioned that the above is just one of the problems for which its help would be invaluable.

FLUORSPAR FOR GLASS MANUFACTURE.

An inquiry was recently made of the Institute as to the extent to which fluorspar is used in the manufacture of glass, and as to its commercial value. Fluorspar (calcium fluoride, calcspar, or fluorite) has only a specialized use in glass manufacture. Fluorides produce opacity, and glass rendered opalescent by them does not transmit red light, but is pure milk white. Fluorspar, however, is not a constituent of the commoner kinds of glass, such as bottle glass and ordinary window glass, and consequently in Australia there is little or no demand for it for glass making, but it is used in practically all kinds of opal glass, milk glass, or alabaster glass. Soon after the commencement of the war, a special Glass Research Committee was appointed in Great Britain to investigate the manufacture of certain glasses made only in Germany and Austria, and its work was so satisfactory that not only were the constituents and the processes of manufacture of these particular kinds discovered, but an improvement in quality was effected, and the knowledge obtained given to the British industry. Only two formulæ out of twelve or fourteen published contain fluorspar. They are what are known as formula No. 2 and formula No. 4:—

SOFT GLASS TUBING.

(No. 2.)

Sand	67.0 per cent.
Alumina	8.3 per cent.
Sodium carbonate	29.0 per cent.
Calc. carbonate	9.6 per cent.
Calc. fluoride	1.6 per cent.

COMBUSTION TUBING.

(No. 4.)

Sand	68.2 per cent.
Alumina	6.2 per cent.
Soda carbonate	5.5 per cent.
Calc. carbonate	13.0 per cent.
Calc. fluoride	1.0 per cent.
Ba. carbonate	8.8 per cent.
Pot. nitrate	4.3 per cent.
Boric anhydride	5.5 per cent.

Pure, clear pieces of natural crystal fluorspar are also used in the manufacture of the highest grade microscope objectives and other lenses. The lenses are ground from the natural crystal and enclosed between glass lenses to protect them from injury.

UTILIZATION OF WOOL SCOURING WASTE.

Although the demand for economy in the United States of America, as in other countries, is insistent, and while the appropriation for very many activities of the Bureau of Agriculture at Washington has been reduced, the vote for investigational work of a scientific nature has been increased. One of the problems engaging attention in that country, as well as in Australia, is the development of methods in utilizing wool scouring wastes that may ultimately mean an enormous saving to the industry. Provision is made for this work to be carried on. During the war the price of wool grease rose from 2½ cents to 25 or 28 cents a lb., and the price of carbonate of potash rose from 4 or 5 cents to 80 or 85 cents a lb. The result was that a number of plants were installed for the recovery of wool grease and potash salts. Before that time these products had gone to waste, and the United States imported all of both products consumed. Not only was there a dead loss, but the waste material had become a source of serious pollution to rivers and other streams. The plants built to handle this business during the war when prices were very high must install the most economical methods for extracting the by-products of the wool scouring wastes if they are to continue in operation at the lowered prices expected when normal conditions are restored. These economical methods are to be worked out by the Department of Agriculture under the new appropriation of $9,000. Every year it is estimated there has been lost to the United States 50,000,000 lbs. of recoverable wool grease. At present prices, this is worth about $8,000,000. There was lost every year, also, about 2,500,000 lbs. of potassium carbonate, worth at present prices about $6,250,000.

THE DYE INDUSTRY.

A substantial increase is made in the appropriation for dye investigations. This year's appropriation is $100,000, as against $70,000 last year. This increase was made so that the Bureau of Chemistry can complete the erection and equipment of the dye-manufacturing plant at Arlington, Va. The dye investigations have resulted in the development of a number of important processes for the manufacture of coal tar dyes. Fifteen patents have been granted on new processes, and processes have been developed for the manufacture of intermediates, used in the making of dyes. Some of these processes are already in use on a commercial scale in the production of dyes and intermediates. Other processes which have been worked out on a small scale are being tried in a small commercial way, and later will be developed on a large scale. Efforts will be made this year to develop new and cheaper processes.

ENTOMOLOGICAL INVESTIGATIONS.

The Bureau of Agriculture is developing entomological research on a very large basis, and instead of allowing the investigations which have been initiated to be abolished, the Government has increased the vote enormously. One appropriation of $250,000 has been made for

the control of the European Corn Borer, now known to exist in two States. The pest is a very serious one, and has spread rapidly within the past twelve months, so that the task of elimination or control has become correspondingly more serious. In order to hold it as closely as possible to the present infested area, the Bureau of Entomology is throwing into the field the largest force possible to enforce the existing quarantine, and to enlarge survey work. Another item is $135,000 for investigations of insects affecting vegetable crops, a large portion of which will be used for the control of the sweet potato weevil. It is the practice in America to tackle plant and stock diseases in a courageous and scientific manner, and the policy has abundantly justified itself by the enormous savings effected.

NEW SUBJECTS OF INQUIRY.

Amongst other items which appear for the first time on the Estimates of Federal expenditure in the United States is $50,000 for the investigation of Flag-smut of wheat, Take-all, and similar diseases of wheat and other cereals infesting soil and seed. Twenty thousand dollars has been set aside for the development of the nut industry, for it is recognised that no tree industry of equal importance presents more difficult problems to the growers. Twenty thousand dollars will be devoted to the investigation of the grape industry and methods of utilizing grapes heretofore used for the production of alcoholic beverages. The improvement of potato seed crops accounts for another $15,000, and this work will be undertaken under the co-operation of those States where potato-growing is one of the major industries. There is a very large increase of the funds for the investigation of tuberculosis of animals, the grant for this purpose totalling $1,500,000.

CITRUS BY-PRODUCTS.

With characteristic acumen, the United States Department of Agriculture set about the experimental work to ascertain whether the culls from orange and lemon crops could not be profitably utilized. The citrus industry is all-important to California, and the problem of how to utilize the rejects and waste fruit was becoming increasingly acute. Fruit which is not fit for shipment because of minor defects, such as small bruises or punctures, has now a commercial value, since the establishment of the experimental laboratory at Los Angeles. As a direct result of the work carried out there, four stable concerns manufacturing by-products, such as lemon oil, citrate of lime, and citric acid, have been established; while twenty concerns are producing orange by-products to the extent of 6,000,000 lbs. each year. Less than five years ago, culled lemons could be had in large quantities for $5 a ton, while to-day, notwithstanding the fact that a large quantity is now available, the price obtained by the grower is $25 a ton. This is only one of many instances showing the value of spending money on experimental work.

TICK INFESTATION AND MILK YIELDS.

Some valuable figures, showing how dipping increases milk production in the case of cattle infested with ticks, are reported by the United States Department of Agriculture. Figures are given regarding one herd of 500 cattle, where the milk production increased 10 per cent. Prior to dipping, from 12 to 15 per cent. of the herd was lost each year because of ticks. Since dipping began, there have been no losses at all. Records that have been kept systematically prove that cows lightly infested with ticks produced 18 per cent. less milk than did tick-free cows; while cows heavily infested produce, on an average, 42 per cent. less milk than similar cows free from ticks. Reduction in milk flow does not always appear in the first milking that follows dipping, even; but it is natural that after a milch animal has been driven a few miles to the dipping vat and has gone through the excitement of dipping, her production should fall off slightly, but this temporary falling off soon disappears, and finally the milk yield is increased, the actual increase being according to the number of ticks that were sucking the blood that should have gone into the making of milk.

The anti-tick campaign is apparently proceeding very satisfactorily, and in one month 7,000,000 dippings of cattle to get rid of the cattle fever tick were carried out. As a result of the organized effort against the tick in the United States, the area over which the pest operates is becoming less and less, and the losses greatly reduced.

A STEEL RESEARCH LABORATORY.

A number of the leading American steel and engineering companies have decided to install an Experimental Rolling-mill, and to establish a Bureau of Rolling-mill Research, under the auspices of the Carnegie Institute of Technology at Pittsburgh. This action marks a notable advance in the spirit of co-operation among American manufacturers. The Bureau of Rolling-mill Research will have four distinct functions:—

1. To investigate and study the physical and mechanical changes taking place in steel and other metals, and the power consumed during the process of rolling at various temperatures and speeds.

2. To distribute the information obtained by means of these experiments among the co-operating firms in order that they may put it into commercial use.

3. To provide laboratory facilities in which the contributing companies may conduct experiments and investigate designs of rolls for the production of new sections which they wish to place on the market.

4. To offer courses of instruction to students employed by the contributing interests, and to those students who are to specialize in this field, and are registered at the Carnegie Institute of Technology.

EDITORIAL.

UTILIZING SLATE WASTE.

For many years the bugbear of slate quarries has been the waste. An average of 10 per cent. of the rock is saleable material, and the cost of quarrying and handling the waste has been a great drawback to the quarries. Numerous experiments have been made with a view to the utilization of this waste, and it is reported that success has now been achieved. Machinery has been installed at Bethesda, in Wales, to crush slate waste to a fine powder, from 60 to 200 mesh, for use in making asphalt and linoleums, for proofing mixtures, for mechanical and moulding works, for weather-resisting paints, and for insulating purposes. It is stated that the powder will supersede, to some extent, barytes, fossil meals, and other powders, and that asphalt manufacturers say that it is the best material possible for their purpose. It is, of course, not likely that the whole of the waste from quarries will be utilized for the purposes indicated, at any rate for the present.

INTERNATIONAL RESEARCH COUNCIL.

Information has already been given in this *Journal* regarding the formation of a National Research Council for Australia as a branch of the International Research Council which has recently been established by Allied and neutral nations to take the place of previously-existing International Committees for work in various branches of science. A meeting of the International Research Council was opened at Brussels last July, in the presence of the King of the Belgians. Much successful work was accomplished. The statutes of the International Research Council were finally agreed to, and unions embracing the whole subject of astronomy and the various sections of geophysics were formed. In other branches of pure and applied science, proposals for the formation of International Unions were discussed and formulated. These will have to be submitted to the National Councils in the different countries and Dominions before they can be formally adopted. Brussels was selected as the legal domicile of the International Research Council. Its triennial meetings will be held in that city, and gifts or legacies will be administered according to Belgian law; but the Unions dealing with special subjects will probably follow the established custom of holding their conferences successively in different countries. The Secretariat of the Council will be at Burlington House, London, where the Royal Society has placed a room at the disposal of the General Secretary.

POWER-ALCOHOL: TRIAL WITH LONDON OMNIBUSES.

The British Departmental Committee on Power-Alcohol has arranged with the London General Omnibus Company to run a number of motor omnibuses for six months on alcohol-benzol and alcohol-benzol-petrol mixtures, the results to be compared with running on petrol and other fuel. It is stated that, by the end of this year, the British Committee will be able to publish information of such value as to enable the Government to take definite steps towards rendering power-alcohol available for all users of internal combustion engines.

As regards mixtures of alcohol and benzol, it may be pointed out that the situation in England is very different from that in Australia. England is, of course, a highly industrialized country with a large population, and there are many gas-works from which benzol can be obtained as a by-product. In Australia, however, there can be for many years no prospect of producing benzol in quantities sufficiently large to enable it to be used extensively as a liquid fuel.

POWER-ALCOHOL: DENATURANTS AND DENATURING.

Alcohol used for power or industrial purposes must be denatured or methylated in order to render it unfit for use as a beverage or for medicinal or culinary purposes. In Australia, industrial spirits must be mixed with 2 per cent. of wood naphtha, ½ per cent. of pyridine liquid, and ½ per cent. of coal tar naphtha or shale naphtha. The cost of the denaturants and of mixing, which amounts to nearly 3d. for each gallon of spirit, has, of course, to be added to the cost of the spirit. These charges add from 10 to 15 per cent. to the price at which the spirit can be sold, and an addition of this nature may make all the difference in the practicability of producing power-alcohol on a profitable basis.

The British Departmental Committee on Alcohol Motor Fuels points out that the use of alcohol as a fuel for power purposes in the United Kingdom has not been commercially practicable hitherto by reason of its high price compared with that of petrol. Since the denaturing process now in use increases the cost, the increase should be restricted as much as possible by reducing the proportion of the principal denaturant, or wood naphtha. The Committee has recommended that in all cases of approved use for power or production purposes, where the user gives bond, the proportion of wood naphtha in the power-alcohol should be substantially diminished, the difference being made up wholly or partially by petrol, benzol, or other nauseous substance, supplemented by a small quantity of methyl-violet as colouring. The Committee emphasizes the point that a further deterrent can be provided by the imposition of much heavier penalties than those now sanctioned by law for evasion of the spirits duty in any case of illicit purification of power-alcohol to render it potable.

The lowest attainable cost for denaturing power-alcohol should be officially recognised as an important consideration, in view of the necessity of securing a non-potable spirit and protecting the revenue against fraudulent practices.

The British Committee has recommended that every effort should be made by research and practical trial to provide a denaturant or alternative denaturants, *e.g.*, formaldehyde, pyridine, and tobacco oil, the employment of which will be effective in the smallest possible quantities and at the lowest possible cost. The Committee considers it essential, moreover, that all restrictions concerning the manufacture, storage, transport and distribution of power-alcohol should be removed as far as possible consistent with safeguarding the revenue and preventing improper use.

POWER-ALCOHOL FROM PEAT.

It is reported that a new method of distilling alcohol from peat has been developed in Sweden. In that country peat is found over extensive areas to a depth of from 23 to 27 feet. It is stated that from 100 kilos. (220 lbs.) of dried peat about 6 litres (1.58 gallons) of 100 per cent. alcohol can be obtained. This is about the same yield as that obtained from potatoes. The method of obtaining alcohol from peat is practically the same as that used in the treatment of the sulphite lyes from paper pulp. The peat is boiled under pressure with sulphuric acid, by which a sugar solution is obtained, together with certain residual products. After the acid has been utilized with lime, the sugar solution is formed and made into alcohol, the residue being collected and made into briquettes for fuel. It is reported that the experiments made with regard to this method of obtaining alcohol have been successful, and that the Swedish Government has agreed to the building of a distillery, on the understanding that the shareholders of the company shall have the right to produce and use the alcohol for motor cars, motor boats, &c., irrespective of Government prohibitions and price regulations.

INDUSTRIAL ART.

A scheme for the establishment of a British Institute of Industrial Art has been prepared by the Board of Trade and the Board of Education, with the advice of the Royal Society of Arts and several well-known bodies of workers in Arts and Crafts. The aim of the promoters of this Institute is to "raise and maintain a standard of excellence in works of industrial art produced by British designers and manufacturers, and in stimulating the demand" for achievement of the highest order. It is believed that one thing essential to permanent supremacy of British designers and craftsmen is the organization of some national intermediary between individual workers and the public, and it is hoped that the establishment of the proposed Institute will fill this need, and will stimulate the artist craftsman on the one hand, and on the other lead the general public to an appreciation of beauty of design and quality in workmanship.

THE UNIVERSITY MAN IN INDUSTRY.

The Universities of Great Britain have decided to co-operate with the Federation of British Industries in the formation of a Central Bureau to facilitate the entry of University-trained men into industry. For many years there has been a small, but constant stream of these men flowing into the industrial and commercial world, and it is stated that, when analyzed after a few years, this stream is found to contain an enormous proportion of really sound and successful men, with practically no real failures. In the past, apart from the gradually disappearing distrust of the "theoretician," there has been the feeling that a University Appointments Board cannot be really alive to the needs of the business man, and would recommend a student purely because he was a good *student*. This feeling will now obviously have no weight, since no one could accuse the Federation of British Industry of having purely academic interests at stake.

ENABLING THE BLIND TO READ.

At the second British Scientific Products Exhibition recently held in London, considerable interest was evinced in the Optophone, which was originally invented by Professor Fournier d'Albe, and later taken up and improved upon by Professor Archibald Barr. This instrument has as its object the enabling of the blind to read ordinary printed type without human aid. The method in which it succeeds is briefly this: The printed page is so arranged over a partial cylinder of glass that light falls through it on to a selenium cell beneath, which is carried on an arm below, that moves it along the lines of type. Since the conductivity of the selenium varies according to the light, the resistance of the selenium cell in passing beneath the black letter press is of course affected, and as it is divided into small compartments, it is affected in a different way by each passing letter. This effect is utilized to produce sounds on a telephone receiver which is worn by the reader, and by learning the sounds produced by the various letters, he is enabled to read the type for himself.

STANDARDIZATION IN THE SHIPBUILDING INDUSTRY.

Before the war, the British shipbuilding industry was undoubtedly second to none. America has, however, made marvellous strides; Italy must be considered as a growing shipbuilding nation; whilst Japan as a rival is only retarded by lack of steel. It is patent, therefore, that if Great Britain is to maintain her supremacy in shipbuilding and marine engineering, standardization of components must be adopted to the utmost limit of interchangeability in order to increase output and meet the ever-growing activity of international competition. To this end, a representative conference of the official nominees of the British Government, classification societies, ship-owners, shipbuilders, and marine engineers was convened last year, at the instance of the President of the Board of Trade, and was held under the auspices of the British Engineering Standards Association. Sir Archibald Denny, the chairman of the Association, occupied the chair at the conference. The result of the discussion was a unanimous recommendation to the main Committee of the British Engineering Standards Association for the formation of a Sectional Committee to deal with this subject of such importance to all those connected with shipping.

SCIENTIFIC LIGHTING AND INDUSTRIAL EFFICIENCY.

In a lecture on "Scientific Lighting and Industrial Efficiency" at the British Scientific Products Exhibition, Westminster, attention was directed to the close relation existing between good industrial lighting and the health of workers, and many instances were given of accidents due to insufficient or badly-arranged conditions of illumination. Light must be regarded as a "tool," and it is absurd to install expensive machinery, and to pay highly-skilled workmen, and then to neglect the relatively small expenditure on illumination necessary to the efficient performance of work. Instances were quoted showing that, as a result of improved lighting conditions, increases in output of from 8 to 27

per cent. had been recorded. Another factor of importance is the reduction in the amount of spoiled work. The cost of lighting forms only a small proportion, in some cases less than 1 per cent., of the wages bill. Good industrial lighting is therefore amply justified on economic as well as on humanitarian grounds.

STANDARDIZATION IN THE UNITED STATES OF AMERICA.

The American Society for Testing Materials has recently held its annual meeting at Atlantic City, N.J. One of the special features of the meeting was the great expansion of co-operative work with other societies, and with testing and research laboratories. From the papers read at the meeting, it is evident that there is great activity in the United States in every branch of research relating to engineering work and building construction. At the Conference, various matters were dealt with under the head of Standardization; and, dealing with the subject of International Standardization, one speaker asserted that "Nothing will promote international trade co-operation and good fellowship so much as the establishment of wide and mutually satisfactory standards," some of which he said are the metric system, the centigrade thermometrical scale, an international coinage system, and the like.

Special attention is being paid in the United States to the standardization of reinforced concrete. The American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute, and the Portland Cement Association have joined with the Society for Testing Materials in forming a Committee to arrange for an organization to deal with the subject of Standardization of Reinforced Concrete.

LARGE SCALE EXPERIMENTAL RESEARCH IN AMERICA.

The Hon. W. C. Redfield, Secretary of Commerce in the United States, in giving recently an account of what is being done in the States to restore industry to a peace basis, and to improve it in the future, stated that the industrial success of Germany arose out of two causes—first, the appreciation of the science which underlay each industry, its study and its application in the industry; and, secondly, the training of the mind as well as the hand of the worker, so that he should understand both *how* to do a thing properly and *why* that was the proper way. Neither in Great Britain nor in America has scientific research or vocational training been conspicuous, or even visible, in industry. Both are now being introduced in America as quickly as possible. Experimental cotton and woollen mills, a paper mill, and a rolling mill, have already been established, and other industrial laboratories are to follow; so that any problem which affects a whole industry can be at once worked out on a practical scale. In England, the Industrial Research Associations being established in connexion with the Department of Scientific and Industrial Research are making similar provision for their particular industries. On the educational side, in the States the Federal Board for Vocational Education is distributing large and increasing sums to each State of the Union to insure to every worker a knowledge of the *why* of his work.

CONCRETE TANKS FOR OIL STORAGE.

The United States Bureau of Standards has published the results of a series of tests to determine the effectiveness of concrete as a retainer of oil. The results may be summarized as follows:—

(1) Various mineral oils, covering practically the entire range of fuel oils, have been stored in concrete tanks for approximately thirteen months, apparently without injuring the concrete in the slightest degree.

(2) A number of vegetable and animal oils have been stored successfully in concrete tanks for a period of thirteen months, and only two, cocoanut oil and lard oil, have appreciably attacked the concrete.

(3) The quantitative losses of pure oils have been determined under a pressure head of 25 feet. The results indicate that heavy and medium weight fuel oils can be stored in concrete without excessive losses. The storage of kerosenes and gasolines under these conditions will probably prove uneconomical unless some impervious coating can be found which will be durable under long exposure to the lighter oils.

(4) In a single test of six months' duration, spar varnish has apparently been effective in successfully retaining a 43-deg. kerosene of 0.015 viscosity. The loss during that period was practically negligible.

NATIONAL ROADS IN THE UNITED STATES.

The value of good roads, and the necessity of uniform methods of construction and maintenance to secure the greatest economy, is widely realized in the United States, and a proposal is now being considered under which the Federal Government will build, in each State, trunk highways, which, when linked together, will form a national system connecting the whole country. The scheme is embraced by the National Highway Bill, introduced into the Senate by the Chairman of the Committee on Post-offices and Post-office Roads. It is proposed that the Federal construction shall be to the extent of not less than 2 per cent, or more than 5 per cent. of the total mileage of a State. The consummation of the scheme will prove a further strengthening of the forces behind road development, and will enable a much wider use to be made of the knowledge gained from the research carried out by the office of Public Roads. At the same time, it will produce more effective co-operation between Federal and State agencies, the one applying its efforts to national connexions, and the other to the development of local or Intra-State roads. Apart altogether from this scheme, however, it is interesting to note that the estimated expenditure for this year on road construction and repair in the United States totals £70,000,000. Both in the United States and in Europe good roads are regarded as essential to the development and maintenance of rural interests, and in view of the enormous growth of motor transport, the question assumes much greater importance.

PROMISING CLAY INVESTIGATIONS.

The work which is being carried out at Ballarat by the Special Committee appointed by the Institute to investigate the clay deposits of Victoria is yielding most promising results. Additional shafts have been sunk at Berringa and Lal Lal, and bulk samples of the clays have been obtained. Tests that have been made of a number of samples suggested that high-grade kaolins, suitable for the manufacture of the better grades of table and toilet ware, occur in Victoria in large quantities. Confirmation of this hope is supplied by the subsequent analyses of these clays and stones. The following table shows the comparison between the chemical composition of a selected Victorian kaolin and that of one of the purest varieties of English china clay obtainable:—

—	Best English China Clay (Lee Moor Devon).	Victorian Kaolin.
Silica S_1O_2	47·1	47·36
Alumina Al_2O_3	39·4	36·30
Ferric Oxide Fe_2O_3	·23	·88
Titanic Oxide T_1O_2	·13	·82
Magnesia MgO	·24	—
Lime CaO	·31	·64
Potash K_2O	·16	·29
Soda Na_2O	·08	·22

An analysis of a good English Cornish stone compared with similar stone that has been located in Victoria reveals the following similarity:—

—	English Cornish Stone.	Victorian.
Silica S_1O_2	70·30	71·96
Alumina Al_2O_3	16·62	15·57
Ferric Oxide Fe_2O_3	1·54	·33
Lime and Magnesia	1·62	·21
Potash K_2O	5·39	8·24
Soda Na_2O	2·57	1·46

Systematic furnace tests are made of the different clays, and the physical properties of the burnt test pieces are carefully measured and recorded. By this means, a complete history of the physical changes which occur at various temperatures in the kiln is obtained. The information which is being collected should prove of general interest and material value to the State.

Scientific Research: An Empire Appeal.

Reproduced hereunder is a copy of a circular issued by Lord Milner, Secretary of State for the Colonies, to the self-governing dominions, colonies, and protectorates of the British Empire, emphasizing the importance of the development of the economic resources of the Empire, and the stimulation of activities for the conduct of scientific research.

The part that science played in the winning of the war is still so fresh in the minds of the public that it is unlikely that its aid towards the solution of the reconstruction problems aris ng out of the war will be openly or widely opposed. Among the leading nations there is a great awakening to the national value of scientific research. During the war the British Government created a Department of Scientific and Industrial Research, with a fund of over £1,000,000 at its disposal; whilst various scientific organizations have taken up various branches of the subject of the development of science, and its co-ordination with industry, education, and administration. France is undertaking a new national institution for scientific research on a large scale.

Germany and the United States had long since employed science as the handmaid of industry. Japan is invoking its help in preparation for the international industrial conflict, and its newly-formed Institute has a sum of £500,000 at its command. Canada looks forward to the expansion of her industries and the exploitation of her resources from the development of research. A permanent body has been established to advise on questions of scientific and technological methods affecting industry. South Africa and New Zealand are also creating national research organizations.

The proposal circulated by Lord Milner aims at the development and co-ordination of scientific research for the betterment of industry throughout the Empire, and also indicates broadly the spheres of action in which co-operative effort can be advantageously employed. It is as follows:—

Downing-street,

11th June, 1919.

Sir,

At the close of the prolonged struggle of the last four years, and having regard to the depletion of raw materials which has been caused and to the vast financial responsibilities which have been left behind, it is evidently more than ever necessary that the economic resources of the Empire in general should be developed to the uttermost, and I wish to suggest to you that the time is particularly opportune for a review of the activities carried on by or on behalf of your Government in scientific

research and economic exploration, and for consideration of all promising schemes, either for new work of this description or for adding to the efficiency or widening the scope of work already in progress.

2. Apart from activities of a primarily scientific nature, such as research in oceanography and meteorology, the field to be reviewed may be very wide and should not be regarded as entirely economic in character. The main portion of the possible field of research may broadly be divided into inquiries relating to sources of mechanical power, agriculture and forestry, geology and minerals, and marine products. In most of these provinces the desirable inquiries may be classified, it is true, without any precise line of demarcation, into inquiries directed to an economic or other practical end which is in sight from the first, and inquiries where the practical aim, though real, is less immediately obvious. I am decidedly of opinion that the latter class of inquiries ought by no means to be neglected, and that if they are well chosen it may be expected that in the long run they will be even more fruitful in results of practical value than inquiries of the former class. The latter class of inquiry, however, demands a scientific staff with higher qualifications, and can scarcely be attacked effectually by a small Colony acting by itself. In such cases possible combination with other Colonies similarly situated should be considered.

3. It is becoming more and more clear that there is scarcely any industry which can develop or even maintain its position without the aid of scientific research, and that it is sound policy that such research should be liberally provided for in the budgets of the firms engaged, although it is frequently necessary that those firms should combine to finance a central research association, or at least closely co-operate in research work in order to cover the whole ground and avoid overlapping. With some assistance from the Imperial Treasury a good deal is being done in this country on these voluntary lines. There will no doubt be certain Colonial firms who can best participate by contributing to the research associations of their industries in this country. But the usual method in the Colonies is for research to be carried on by the scientific departments of the Government, and financed out of the ordinary revenue and out of taxes on particular industries, while a subsidiary but important method is that of contribution to institutions for research and the like, usually situated for convenience in this country, some official, such as the Bureau of Entomology and the new Bureau of Mycology, and some unofficial, such as the research associations referred to above, which are organized under the auspices of the Department of Scientific and Industrial Research.

4. Broadly, I would ask you to consider the position of any important industries in the Colony on whose behalf no research work is at present carried on, and whether this state of affairs does not call for action on the part of the Colonial Government. I would particularly direct your attention to those raw materials required for Imperial trade or defence which are produced within the Empire either in inadequate quantities or not at all, such as flax, hemp, medium stapled cotton, the lighter timbers, ores of aluminium and copper, phosphate rock, potash and mineral oil. The question of the possible establishment or extension of fishing industries for export is also worth attention.

5. The Committee on Commercial and Industrial Policy after the War drew special attention to this question of raw materials in paragraph 122 of their final report (Cd. 9035). Much of the existing deficiency can be supplied by the tropical Colonies and Protectorates if their great potential resources are adequately developed, and one of the most sure and speedy agents in such development is undoubtedly scientific investigation. The war has furnished a striking instance of the correctness of this view. One of the conspicuous examples of material produced to an insufficient extent within the Empire, to which the Committee called attention, was bauxite, the ore of aluminium. At the present time this country is almost entirely dependent on foreign sources of supply, and there is reason to apprehend that these will remain both costly and insufficient. Aluminium is essential to a number of British industries, and the position would be serious if alternative sources of supply had not been found within the Empire. The scientific investigations of the Director of the Geological Survey of the Gold Coast have recently resulted in the discovery of a very large deposit of the mineral in that Colony, and it is hoped that arrangements can be made which will enable it to be worked on a paying basis. Valuable deposits of bauxite have also been found in British Guiana, and are now being developed. Other deposits in the same Colony are now under investigation. If these enterprises are successful, the position of the British industries in question will be greatly strengthened.

This is a solitary instance, but it is typical, and could, if necessary, be supported by others drawn from different parts of the Empire. There can indeed be no doubt that a sound and adequate scheme of scientific investigation would be of the utmost value in developing the resources of the Colonies.

6. Another example of the need of research is furnished by the destructive agencies of various kinds, such as animal and plant diseases, insect pests, &c., which are responsible at the present time for an enormous amount of damage in the Colonies. Such damage can literally be assessed in millions of pounds. Valuable work in this sphere has already been done and continues to be done in many parts of the Empire, but there is undoubtedly great scope for extended research. Such work is likely to prove exceedingly fruitful, since many of these destructive agencies are widely distributed, and scientific discoveries which have been made in one Colony can often be utilized elsewhere. The scale on which this destruction takes place is well illustrated by a recent despatch from the Acting Governor of the East Africa Protectorate reporting that "more scientific and progressive methods must be adopted in dealing with stock diseases in native reserves if the future welfare of the stock industry is to be secured. It would be difficult to estimate the annual loss from the ravages of stock diseases in native reserves, but if it were placed at the low estimate of 12 per cent. it would easily represent a sum of approximately £1,000,000 per annum."

7. In Colonies and Protectorates whose financial resources are on a smaller scale than in the one under your government, there has hitherto often been great difficulty in finding the means to carry out investigations in themselves very desirable. I am glad to be able to inform you that, for the benefit mainly of such Colonies and Protectorates, I have

obtained the consent of the Lords Commissioners of the Treasury to the provision of a liberal grant of £20,000 a year from the Estimates of the United Kingdom for 1919-20 and the four following years, to be expended in stimulating scientific research with a view to developing the economic resources of the Colonies and Protectorates. This grant, if it is duly voted, will be administered by a small Committee, to be known as the Colonial Research Committee, which will work in co-operation with the Department of Scientific and Industrial Research, the Imperial Mineral Resources Bureau, the Universities, particularly those of industrial districts, and other existing institutions. In the first instance, the members of the Committee will be Mr. H. J. Mackinder, M.P. (Chairman), two Assistant Under-Secretaries of State for the Colonies, and Sir Frank Heath, the Secretary of the Department for Scientific and Industrial Research. The grant, liberal though it is, is evidently insufficient for a large number of researches, and the Committee will have to content itself with selecting for investigation a few of the most promising of the subjects which may be brought to its notice. It may sometimes be the case that a research may be required which would be chiefly in the collective interests of the Empire or in the interests of some part of it other than the part in which the research would be carried out. If it were convenient that such a research should be undertaken by a Colonial Government, the fact that that Government is prosperous would not debar it from participating in the grant.

8. To the whole question of research and investigation raised by this despatch I attach the greatest possible importance, and I trust that you will give it your personal consideration, in consultation with your scientific and economic officers and with suitable members of the unofficial community, and that you will then furnish me with a brief review of the present position of affairs, and with an account of the further steps which in your judgment should be taken in the near future.

9. There is no objection to the publication of this despatch.

I have the honour to be,

Sir,

Your most obedient, humble servant,

MILNER.

The Value of Irrigation.

The Murrumbidgee Scheme.

By E. N. ROBINSON.

No. II.

The Murrumbidgee scheme, as previously indicated, is too large for one to attempt anything more than a broad, general outline of its principal features. With an irrigable area of 200,000 acres, there must necessarily be differences in the chemical composition and in the mechanical condition of the soil. On the whole, however, the quality is uniformly good. Here and there patches may occur whose physical properties may impose narrower restrictions upon the utilization of the land, especially in the case of the unskilled irrigationist. Even so, as far as one can read the future, this limitation of choice of enterprises should not act as a break upon the progress and ambitions of the settlers.

BUILDING A CHANNEL.

Accepting, to avoid disputation, a widely-held view that the mechanical condition of some of the land prevents the cultivation of lucerne, and cuts the choice of the land-holder down to the cultivation of stone fruits, or of cereals, there is no need at this stage to waste sympathy upon the man who undertakes either of these activities.

Fruit-growing has for so long occupied such a minor and obscure place amongst our primary industries that it is still commonly accepted as being of little importance, and deserving of even less encouragement. That view must change. The fault in the past has

lain in the utter disorganization of the industry and the disinclination of growers to meet the requirements of the trade. Specialization must be practised if profitable results are to be obtained.

At Yanco, a scheme has been designed which should remove these long-standing difficulties. With an eye to overseas trade, in addition to the fulfilment of home requirements, an enormous canning factory has been erected, and encouragement is given to the cultivation of varieties which are suitable for preserving. The existing factory is the second that has been built. The first installation soon proved too small for the produce to be treated, so it was discarded. The present structure is an immense affair, and is equipped with the most modern appliances. It is claimed to be one of the most economically equipped installations in the world, and it certainly conveys the impression of high efficiency.

FOUR-YEAR-OLD PEACH TREE.

Expert assistance was obtained from America to put the plant into running order, and it is now conducted under the supervision of a local settler, whose aptitude for management was quickly demonstrated.

Huge as this factory is, however, it is none too large in the busy seasons for its purpose. But, at the present stage of development, the busy seasons are not long enough. There are one or two rush periods, and then for weeks the building, wherein hundreds of girls and men find employment, is deserted. As settlement proceeds, and a well-ordered system of planting is widely adopted, large supplies to the factory will be maintained over months, instead of weeks, and the running costs of the factory will be proportionately reduced.

One of the initial steps taken by the Irrigation Commission upon the inception of the scheme was to plant an experimental orchard, and the experience which has been accumulated, even in so short a space of time, is proving of immense value to the settlement. From the knowledge gained of the behaviour of fruits under observation, advice now can be given with confidence to the settlers as to the varieties that can most profitably be grown, and they are being encouraged to extend their choice by selecting, not merely one or two favoured kinds, but others which will either mature early or late in the season. This prolongation of the picking period will mean constant employment at the factory and the economic running of the plant. A policy of this kind should require very little effort to commend its acceptance, and as the acreage expands there should be large and regular supplies from the earliest fruiting period to the latest.

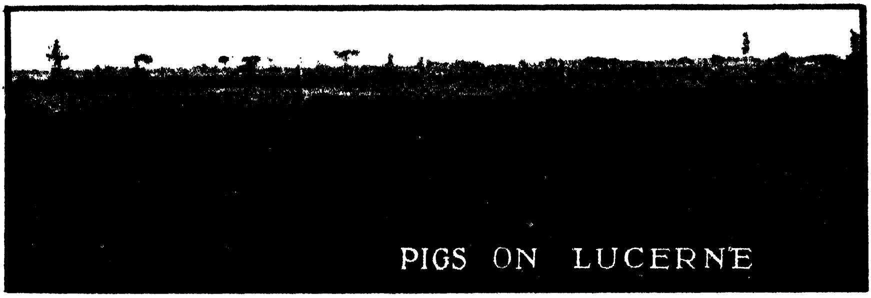
The gloomy view, in regard to the future of the fruit industry, taken by those who are not engaged in it, or who are not as favorably circumstanced as the growers at Yanco, is not shared by the men around Leeton, whose trees have commenced to yield. Probably there have been failures in the past, and certainly there will in the future. Any land settlement scheme, where the opportunities of one man are similar to those of all of his competitors or co-workers, must be judged, not by the failures, but by the successes. Enough settlers are making a success upon this area to refute any suggestion that the land possesses inherent, insurmountable difficulties. It is no longer a question whether the fruit can be grown. It is being grown—grown in large quantities on small areas and of exceptional quality. That much having been established, the suitability of the soil has been incontestably demonstrated. Hundreds of acres are being added to the acreage annually, which is further evidence of the attractiveness of the proposition. The future of the men engaged in the industry will depend upon the efficiency of the organization they provide for the disposal of their crops. California possesses no advantage which is not enjoyed by the growers at Yanco, or, for the matter of that, on some of the Victorian irrigation areas. A close study of their methods, and an inquiry into the organization of the Californian Citrus-growers' Association, which annually handles millions of dollars worth of fruit, should, in this connexion, prove profitable. In the meantime, the Government is providing valuable assistance, and gives the growers representation upon the board of management of the factory.

Figures quoted in the first article indicate the fast growth of the dairying industry. A glance through the factory returns shows some remarkably high individual returns, and in the circumstances, some remarkably poor ones also. How far these wide variations were due to skilful management as opposed to indifference, inefficiency, or sheer ignorance, months of investigation would be required. Many factors might operate. A variation in the quality of the herds, and of their general treatment, and in the kind and amount of the fodder provided, would all affect the question. But here, as with the fruit industry, the proportion of successes is sufficiently high to pronounce judgment upon the land. An extensive range of crops can be grown, but as a general rule, lucerne is the mainstay.

THE VALUE OF IRRIGATION.

The numerous and diverse forms of agriculture that are being practised is one of the most striking features of the settlement. A predilection for almost any land industry can be gratified. One grower during the last summer harvested a highly profitable tobacco crop. Lamb-raising is being carried out by many of the settlers, and the location of the settlement in the centre of a large and important grazing area of the State frequently offers exceptionally favorable opportunities for dealing in store sheep. Pig-raising is another remunerative branch of animal husbandry. In the main it is an adjunct to dairying, a special advantage arising from the ability to graze the young pigs on lucerne. At present there is no indication of hog-raising becoming the specialized industry that it is in many parts of the United States, but this is largely a matter of evolution, and when the economic pressure is felt the irrigation areas may be expected to give the lead in Australia to this undertaking.

The Mirrooll area is at the present time a scene of great activity. The New South Wales Government has embarked upon a policy of land settlement upon the irrigation settlement for the returned soldier which is extraordinarily generous to the applicant who qualifies, and quali-



PIGS ON LUCERNE

fication is simply the proof of some aptitude for farm life and an earnest of his intention to try. To demonstrate these qualities the ex-soldier must serve a probationary period in one of the large camps that have been established and take part in the work of clearing, grading, and other operations incidental to the preliminary preparation of the land. Unsuitable men are eliminated by this initial test, and the suitable men are provided with blocks. A big area of country has been reserved for them, and the quality is as good as any within the Murrumbidgee scheme. Successful applicants are financed until their holdings become productive, which, in the case of the fruit-grower, may represent a five-year period, and in the case of the dairy-farmer up to two years.

Several hundred men are now undergoing preparation for their life on the land, or have already been placed in possession. Thousands of acres of scrub are being knocked down and burnt off, teams by the dozen are ploughing and grading, and miles and miles of irrigation and drainage channels are being excavated. A wise precaution is being taken against the appearance of salt. So far there has been no indication of its presence, but as much of this new area was originally Mallee

scrub the Government is taking no risks, and should it exist it is unlikely to cause very serious damage. All the irrigation channels are being concreted in order to prevent seepage, and an excellent drainage scheme is being provided.

Irrigation farming in Australia is bound to encounter much more opposition before it finally breaks down the ignorance and prejudice which now oppose it. Some initial failures at Yanco have certainly retarded development in New South Wales, as similar failures in the Goulburn Valley kept it back in Victoria. But there have been innumerable failures in dry farming in all parts of Australia, and it is as reasonable to argue the unsuitability of the Commonwealth to grow wool or wheat, if this is to be the basis of judgment, as it is to pronounce a verdict upon irrigation because every man who goes upon an irrigation block does not prosper. Success depends mainly upon the man. The science of irrigation requires to be learned, and intelligence, sustained labour, and experience are necessary before good results can be obtained. It can safely be said that the Yanco scheme provides all the natural elements of success. The human factor will make or mar it.

There are many reasons why agricultural research should form a prominent feature of the activities of the Commonwealth of Australia. Its ultimate aim is to increase the productivity of the country, and it would be impossible to exaggerate the importance of that at the present juncture; for, when the war clouds have passed away, when men have beaten their tanks into tractors and their bayonets into binder-blades (to modernize a scriptural quotation), and peace once more comes to this troubled world, there will be a huge bill to pay, and that bill can only be paid as the result of increased—and greatly increased—production.

—*Professor R. D. WATT.*

Science and its Application to Marine Problems.*

By PROFESSOR J. C. McLENNAN, F.R.S.
(Scientific Adviser to the British Admiralty.)

1. Introduction.

In the great struggle which has now been brought to its close, the introduction and use of the submarine as an agent of unrestricted warfare by our former enemies constituted a menace of paramount and vital importance to the safety and welfare of the British Commonwealth and its allied nations.

As early as 1915 a Board of Inventions and Research was established for the purpose of developing anti-submarine devices and systems capable of coping with the menace. In the autumn of 1917, after exhaustive researches had been carried out by this Board, it was finally realized by all that the submarine problem was one of the most difficult ever presented to science for solution. It became clear that it was necessary to introduce into service practically a new system of physical science and engineering, and it was, therefore, decided to set up with the Admiralty a Department of Research and Experiment, under the direction of Mr. Charles H. Merz. In the Naval Service, too, a special Anti-Submarine Division was organized, and in the Department of Torpedoes and Mines provision was made for greatly extending, by research, experiment, and trial, the capabilities and use of improvements in mines and torpedoes as aids to naval warfare.

As a result of this great effort, it may be stated that by the late summer of 1918 it became clear to those associated with the movement that the submarine problem was well in hand from a scientific point of view, that the character of the means of coping with the menace in an effective manner was clearly defined, and that the elimination of the pest was only a matter of a few months' time.

In the following paper a brief survey is given of some of the most notable advances made in dealing with certain naval and marine problems presented to us on the naval side during the war.

2. Anti-Submarine Measures and Devices.

(*a*) *Listening Devices.*—As the power of the submarine in its attack is due to invisibility, it is clear that, in countering it, methods must be employed which will reveal its presence and give definite information regarding its movements. Of all the physical disturbances emitted or produced by a moving submarine, the pressure waves set up in water by vibrations having their source in the vessel are the ones which are propagated to and are detectable at the greatest distance. Efforts were, therefore, directed from the first to the development of listening devices. The investigations in this field were exceedingly ramified, and were pressed with great vigour.

As a result, great improvements were made in hydrophones. In the development of these devices, microphones and magnetophones of

* Condensed from a paper read before the North-East Coast Institution of Engineers and Shipbuilders.

exceedingly high sensitivity were realized, and after enormous labour, ways and means were devised for standardizing their construction and their functioning. Hydrophones were constructed and put into service which were suitable for use in water of moderate depth, and other types were made which could be used in water of great depth. In one particular type of instrument modifications and attachments were introduced which enabled one to detect with it the direction of bearing of a source of sound with a fair degree of accuracy.

But probably the method of determining the direction of a source of sound waves in water which has proved to be the best is founded on the fact that the sound wave is in the same phase at all points of its wave front. Thus, if there were two hydrophones, in themselves non-directional, placed in the path of the incoming sound, they can be used for finding the direction of the origin of the sound if the phase difference between the sounds received can be detected. There are two ways of doing this—the "binaural" method and the "sum and difference" method. The binaural method depends on the fact that if the sound from one receiver is conveyed to one ear, and that from the second to the other ear, the impression is formed that the sound comes from a certain direction, and this direction is interpreted by the sensations experienced, changes as the phase difference is altered. It can be brought to a certain position with respect to the listener—say, to the position directly in front—either by rotating the two receivers about an axis or by introducing an artificial delay in some form of "compensator." This binaural method, which has great interest from a psychological and physiological point of view, has been the subject of much work on the part of both British and American scientists, and in the anti-submarine campaign it was found to be of very considerable service.

In the "sum and difference" method, the impulses from the two receivers are united before reaching the ear, the combined effect observed being a maximum when there is no phase difference between the waves and a minimum when the phases are in opposition.

Although an enormous expenditure has been made in time and effort to perfect the hydrophone and other listening devices, it is realized that such instruments possess an inherent defect. If the submarine can be made noiseless in motion, this method of countering it becomes ineffective. Even now the range of hearing is not more than 100 yards in the case of modern submarines moving at 2 or 3 knots.

(*b*) *Echo Methods.*—Owing to the fact that it was found possible under certain conditions to render the propulsion of submarines practically silent, it became necessary to look in other directions for fundamental methods of detecting them. A system of detection, which is full of promise, involves the use of a beam of sound waves sent out by a chasing ship in a manner analogous to the use of a searchlight. With such beams of sound waves, it is possible to sweep the seas, and when an object of sound such as a submarine happens to come within the beam, the sound waves are reflected, and echo effects are obtainable. The character of the beam is, of course, determined in large measure by the frequency of the waves constituting it. The method has been employed with great success, and promises to be a very helpful agent. It can

be used by chasing ships travelling at all speeds, and when applied with certain restrictions and definite characteristics, it enables one to pick up and close on a submarine situated more than a mile away. The method, it is obvious, is applicable to the locating of minefields and other obstacles to navigation, as well as to submarine chasing.

(c) *Magnetic and Electromagnetic Detection.*—Magnetic detectors usually require the movable system to be poised or pivoted. They can, therefore, be used as yet with only a moderate degree of satisfaction in towed bodies or in vessels subjected to violent mechanical disturbances. The range at which magnetic effects can be detected is, moreover, comparatively short. As a result of these defects, the use of magnetic detection is somewhat circumscribed. Such instruments can, however, be used under certain conditions, and in particular sea areas with great effect. In the war, very considerable results were actually obtained by their use.

The range at which electro-magnetic detection can be applied is greater than is possible with magnetic detection, but the method is, however, essentially a short-range one, and in many of the forms in which it has been worked out it cannot be used with success at distances greater than about 300 yards, or in depths greater than about 100 fathoms.

(d) *Leader Gear.*—An important application of an electro-magnetic effect which was developed during the war is found in what is known as Leader gear. This gear consists of a cable laid on the bottom of the sea along the course of a narrow tortuous channel leading into a harbor or through a minefield. If an alternating electric current be passed through such a cable, it is possible, by means of delicate devices installed on a ship, to obtain either oral or visual indications of the presence of such a cable, and by these indications the ship can be guided in safety in fog or darkness at speeds as high as 20 knots almost with as much precision as a tramcar by trolley wires over a railway. Experiment has shown that it is a simple matter to apply this method in water of suitable depth for distances as great as 50 miles or longer.

(e) *Invisible Signalling.*—Research has shown that it is possible, under certain conditions, to utilize polarized light or ultra-violet and infra-red radiations for secret signalling. With the last-mentioned type of radiation, especially valuable results are obtainable over considerable distances, even in the presence of light fogs. Where it is not advisable to use wireless communication between chasing ships, infra-red signalling is of special value.

(f) *Wireless Telegraphy and Telephony.*—One of the most remarkable developments which have taken place in the war is in the field of wireless telegraphy and telephony. By the use of oscillating thermionic valves especially great progress has been made. It is now possible to hold conversation with ease between a land station or a ship and an airship or seaplane over considerable distances, and by this means observers on aeroplanes or aircraft can also converse with one another. With high-power installations, it has been demonstrated that wireless telephonic communication can be maintained on the sea over hundreds of miles.

On the directional side of "wireless" great advances have also been made. If an aeroplane, an airship, or surface ship should send out

continuously for a short interval a series of ether waves, these waves can be picked up over long distances by devices installed in a land station, the direction of the source of these ether waves can be ascertained, and in a minute or two the land station can give the observer of the emitting source his bearing within two degrees relative to the land station. With two land stations, it is possible to obtain cross-bearings, and the latitude and longitude of the sending air or surface ship can be determined with a high degree of accuracy.

With directional devices installed on ships, it will be possible for two ships whose positions are known to communicate its true position to a ship enveloped in a fog, and situated several hundreds of miles away. It is obvious, therefore, from the few illustrations which have been given, that directional wireless will find a wide field of usefulness in the future in connexion with the subject of navigation.

(*g*) *Explosion Pressures.*—In the early days of the anti-submarine campaign, a method of destroying submarines whose approximate location was known was by the employment of depth charges. To use this means, it was necessary, first of all, to know the neighbourhood in which the submarine was located, and then the chasing ship would rush to the spot and drop or throw to some distance charges of explosive which detonated when they reached a definite distance below the surface of the water. The necessity of knowing the destructive zone of any given type of depth charge soon became evident, *i.e.*, to determine the radius from the exploding charge, within which a submarine would be successfully destroyed. The same information was important in the laying out and use of minefields. Investigations were undertaken to determine what pressures were generated by charges of different sizes and types at various distances from the place of detonation. The nature of the pressure wave was particularly important, for upon it depends the "killing power" of the charge. The laws which govern the alteration in form and power of waves generated by these explosions had to be determined in order to employ depth charges and mines in the most effectual and economical manner. The accurate determination of the velocity of propagation of the explosive waves generated was also of importance in distributing the charges, for if waves from two different sources arrive at the object in different phases, the effective crushing power may be considerably altered. When we know what the effect of different charges at various distances is—what type of pressure wave, whether a sudden intense blow lasting a few ten-thousandths of a second, or a series of less intense shocks, has the greater effect in destroying the submarine when under water—then we shall know how best to lay out our mine-fields, and what size and type of charges are the best and most economical to utilize under the various situations which may arise.

(*h*) *Sound Ranging.*—In the course of our investigations of the characteristics of pressure waves generated by the explosion of charges in the sea, it was found that when a hydrophone was used to pick up the waves a good record could be obtained by the explosion of a No. 9 detonator at least 2 miles away. The explosions due to charges of 2 lbs. T.N.T. have been recorded at 14 miles, and might have been recorded at far greater distances, judging from the strength of the signals received. The explosions of 300-lb. depth charges have been

recorded up to 200 miles, and it is probable that, with charges of moderate amount, explosions occurring as far away as 500 miles can be readily recorded. Based on these results, a system of sound ranging under water was developed.

Four hydrophones were laid out 5 miles apart along a base line in deep water a mile or two from the shore, and, in addition, two pilot hydrophones were placed along a line at right angle to the base line, the one 5 miles out, and the other at twice that distance. Cables were laid from the hydrophones to a recording instrument situated in a shore station. Four of these stations were installed at different places along the east coast of the British Isles, and other stations are now in progress of installation. With such sound-ranging systems, the shock of distant explosions occurring under water affect the various hydrophones in turn, and as time intervals can be read to two or three thousandths of a second with the apparatus now in use, it is possible to measure with accuracy the time intervals between the times of arrival of a sound wave at the different hydrophones. With the measurements of these time intervals it is a simple matter to deduce the position of the point at which the explosion setting up the wave is located. Up to 50 miles, the location of an explosion under water can be determined to within a few hundred yards by a single station, but for accuracy the co-operation of two stations would be necessary to locate explosions at greater distances. Within operable ranges a ship can be given its position by sound-ranging more accurately than by directional wireless, or by any other known method. Explosions of mines or torpedoes at any point in the North Sea can easily be located by stations situated in Great Britain.

In the war, during the bombardment of the Belgian coast, it was a common thing for a monitor to proceed in a fog to a position some miles from the coast, and, by dropping depth charges, have its position accurately determined from stations on the coast of England. So accurately was this done that it was found, when the monitor's guns were trained in selected directions, objectives several miles inland could be hit with regularity, and with a minimum expenditure of ammunition.

(*i*) *Helium.*—Shortly after the commencement of the war, it became evident that if helium were available in sufficient quantities to replace hydrogen in naval and military airships, the loss in life and equipment arising from the use of hydrogen would be enormously lessened. Helium is most suitable as a filling for airship envelopes, in that it is non-inflammable and non-explosive, and, if desired, the engines may be placed with the envelope. By its use, it is possible to secure additional buoyancy by heating the gas—electricity or otherwise—and this fact might possibly lead to considerable modifications in the technique of airship manœuvres and navigation. The loss of gas from diffusion through its envelope is less with helium than with hydrogen, but, on the other hand, the lifting power of helium is about 10 per cent. less than that of hydrogen.

It was known that supplies of natural gas containing helium in varying amounts existed in America, and it became evident, from the preliminary investigations made by Sir Richard Threlfall, and from calculations submitted by him as to the cost of production, transportation, &c., that there was substantial ground for believing that helium could be obtained in large quantities at a cost which would not be prohibitive.

In the spring of 1917, when the United States had decided to enter the war on the side of the Allies, proposals were made to the Navy and Air Board, and to the National Research Council of the United States, to co-operate by developing the supplies of helium available in the United States. The authorities cited agreed to co-operate with vigour in supporting these proposals, and large orders were at once placed by them with the Air Reduction Company and the Linde Company for plant, equipment, cylinders, &c. The Bureau of Mines also co-operated by taking steps to develop a new type of rectifying and purifying machine. By July, 1918, the production of helium in moderate quantities was accomplished, and from that time forward the possibility of securing large supplies of helium was assured.

The advances actually made at the time the armistice was signed warrants the opinion that by the present time, had the work projected been completed, supplies of helium at the rate of 2,000,000 cubic feet a month would have been produced within the Empire and the United States at a low cost, helium-filled aircraft would have been in service, and great progress would have been made in exploiting the technical and scientific uses of this gas.

Before the war a proposal to utilize helium as a filling for airships would have been viewed, even by most scientists, as impossible, but, thanks to the enterprise, enthusiasm, and initiative of the Navy, backed by imagination, a suggestion—at one time considered to be chimerical—has to-day become a realization.

3. Defensive Measures.

From time to time publicity has been given to the steps taken by the British Navy, in co-operation with the Navy of the United States of America, to close to the passage of submarines such sea areas as the northern portion of the North Sea and the Straits of Dover.

At the time of the signing of the armistice, this stupendous task was well advanced. The material used consisted largely of ordinary contact mines, which were used in vast numbers, and at the expenditure of enormous labour and capital.

It can be stated now, however, that, concurrently with the installation of this system of defence, other systems of dealing with these and similar areas were worked out, which involved the use of more subtle mechanisms in quantities which were vastly smaller in amount.

To-day it is scientifically possible and practicable, with a comparatively small amount of material, to close effectively to the passage of submarines by either automatic mechanisms or by controlled ones, such sea areas as the Bristol Channel, the water stretch between the Mull of Cantyre and the north coast of Ireland, the Straits of Dover, the sea area between Belgium and Denmark, the Cattegat and Skager Rack, and the greater portion of the North Sea between the Orkneys and Norway.

This will serve to show you, in a measure, the part science has been able to play during the war. Had the knowledge we now possess been available at the opening of the war, we should have been spared much

inconvenience, suffering, and anxiety, for the submarine menace, at one time threatening and uncomfortably dangerous, would never have been able to materialize.

4. Applications of Science under Peace Conditions.

Under peace conditions many important technical systems and devices brought forward during the war will find immediate application as aids to navigation.

By means of directional wireless systems, ships or aircraft in the English Channel, the North Sea, or in the eastern and western portions of the North Atlantic, can be given their positions when prevented from getting it by the existence of fogs or unfavorable weather.

By means of sound-ranging, it is possible to fix the positions of light vessels, buoys which indicate channels and obstructions, such as sunken ships. Ships steaming in fog up the Channel, or approaching the shores of Nova Scotia, Newfoundland, or Labrador, can be given their positions with accuracy for ranges up to as much as 500 miles.

Seaplanes and aircraft in distress in the neighbourhood of the British Isles or near the coast of America can call for help and be located when wireless gear becomes inoperable by simply dropping depth charges.

In hydrographic work generally, sound-ranging will be of the greatest service, for surveys can be made, and investigations of sea-beds carried out, in fogs as well as in fair weather without the delays which have been experienced in the past. The positions of the localities being investigated can always be determined in a few minutes when once a sound-ranging station has been established on some shore within reach.

By Leader gear laid in such areas as the River St. Lawrence, the entrance to the Thames or to Halifax Harbor, the Straits of Dover, &c., in-and-out lanes of traffic can be organized which can be maintained with ease in fogs.

The echo methods to which reference has been made can be used for sounding, for locating icebergs, surface vessels, and rock-bound coasts in a fog, as well as for locating submarines.

Helium, which was originally produced as a filling for airships, can be utilized for the production of illuminating agents, and for providing a means for investigating the fundamental properties of matter at the lowest temperatures attainable by man.

Developments in internal combustion engines, in electric drive, and in the fuel values of new materials, which were to be corporated in the Navy, will be of enormous value to the mercantile marine in the future.

Advances made in wireless telegraphy and telephony, and in secret signalling by specific types of radiation for war purposes, will also prove of great service under peace conditions by providing us with novel, efficient, and less costly methods of communication.

5. Proposed Scientific Establishments for the Future.

With a view to developing and extending the scientific results which were obtained under stress of war, the Admiralty has recently put forward proposals for the permanent establishment of a Department of Research and Experiment within the Navy.

Plans have been formulated for the erection of a Central Research Institution for the investigation of first principles, and for carrying on researches of a fundamental and pioneer character. Steps have already been taken to organize a sea experimental station, and to provide buildings and equipment for an engineering laboratory, a wireless and signal school, and a torpedo and mining school in place of Vernon.

It is believed that these institutions will prove of great value in developing not only means of increasing the efficiency of the Navy, but in providing aids to navigation for our mercantile marine.

The initial expenditure for buildings and equipment will be large, but it seems evident that an ample financial return will in a short time be obtained for the nation from profits accruing from a lowering of the rates of insurance and from a reduction in the cost of transportation. If we could, by the use of such aids to navigation as have been referred to above, prevent two or three wrecks per year, or lower the time of passage between Great Britain and Canada on the average by one day per voyage per ship through the fog-covered areas in the neighbourhood of Newfoundland, sufficient funds would be saved in a year or two to cover the whole cost of the expenditure on scientific and experimental establishment, and on the prosecution of the researches and investigations foreshadowed.

The British people had ignored science, or at best held it at arm's length. Our policy of "muddling through" had covered almost every sphere of human activity. We prided ourselves on being a "practical people," and regarded science as a mere plaything for theorists. In the scheme of our great industries science was, until quite recently, treated as an Ishmael. Even now she was viewed with suspicion, yet to hope for success in modern industry without the aid of science was like attempting to navigate the trackless ocean without a compass.

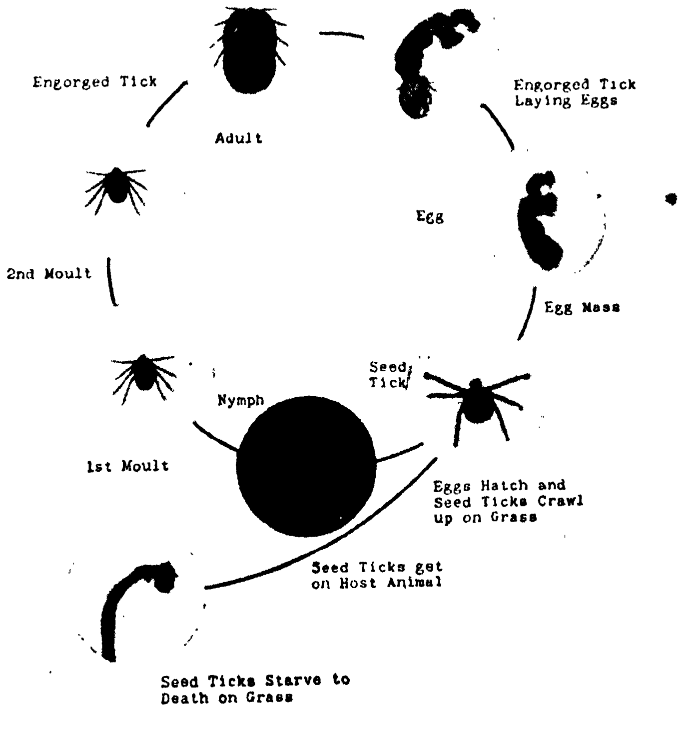
—W. M. HUGHES.

Control of the Cattle Tick.

Life History Investigated.

By T. HARVEY JOHNSTON, M.A., D.Sc.,
Professor of Biology, University of Queensland.

The enormous losses caused by the cattle tick pest in Australia, combined with the fact that no systematic research in connexion with the biology of the tick had been carried out in this country, induced the Institute of Science and Industry to appoint a special committee to undertake searching investigations on this subject in Southern Queens-



LIFE CIRCLE OF CATTLE TICK.

land. Previous references in *Science and Industry* have indicated the seriousness of the scourge, which, on a conservative estimate, has inflicted a monetary loss upon Queensland alone of at least £7,000,000.

The life history of the tick must be known in order to appreciate the steps which are being taken to combat and control its ravages. When the female tick becomes fully matured, she detaches herself from her host, and falling to the ground, seeks some secluded spot, where she remains quiet for from two to ten days in summer, or from two to three weeks, or even longer, in winter; after which she commences to lay eggs. The number laid varies from about 2,000 to 5,000—the average being about 3,000. Those which hatch out vary from 9 to 98 per cent. Immature females also lay eggs, but in smaller numbers. These eggs appear as dark, reddish-brown, ovoid wax-like bodies, about one-fiftieth of an inch long, and one-sixty-sixth of an inch broad at their widest part, and they are very resistant to external influences. Moisture has but little effect upon them, consequently the spread of ticks by heavy rain washing the eggs from one pasture to another may occur. Protracted exposure to direct sunlight destroys their fertility, but they are capable of withstanding the effects of low temperature (even 15 degrees F.) to a remarkable extent. Under favorable conditions, the eggs proceed to develop larval or "seed" ticks, the time required for which varies from a fortnight to three weeks or more, depending upon external influences, such as temperature, moisture, shade, &c. Warm, moist weather, such as that of our coastal areas, is most conducive to speedy hatching.

Since each female tick lays an enormous mass of eggs at one spot, thousands of larvæ appear in the course of time at the same place, ascend the vegetation, fencing, &c., and collect in masses ready to swarm upon any object that brushes past. They do not appear to display any discernment as to the object they attach themselves to, as is evidenced by their swarming on inanimate articles, such as one's own clothing, blankets, &c. Their parasitism is, however, so perfect that, unless they attach themselves to a suitable host, no further development occurs; they soon fall off, and in time perish. They are very tenacious of life, and have been known to live for nearly eight months during the colder part of the year in America.

Field experience suggested the possibility of this period being exceeded in our temperate and sub-tropical coastal areas, and to ascertain more definitely the life-history of the tick, research work, as aforementioned, was instituted. Professor T. Harvey Johnston, who carried out the investigation, has furnished a report which, save for the deletion of a tabular statement of the work at the experimental plots upon which his conclusions are based, is substantially as follows:—

In August, 1917, the writer was asked by the Executive Committee of the Advisory Council of Science and Industry to carry out investigations regarding the biology of the cattle tick, with a view to determining the length of time taken by the tick to pass through its different stages—especially the egg and larval periods—in different localities and under different conditions, preference to be given to certain matters, which included the following:—

1. The period elapsing between the dropping of the engorged female and the commencement of hatching of the eggs laid by it.

2. The result of various external conditions on the life of the larva; and also the duration of life when the larva was subjected to total starvation.

The relationship of the desired data to the question of quarantine will be readily recognised, since they should furnish facts on which a reasonable period of quarantine could be based, such period varying, as has now been ascertained, according to the time of the year, and also to certain climatic conditions.

Four stations were established towards the end of 1917, viz., at the University, Brisbane, as head-quarters; Woolooga (on a tributary of the Mary River); Toowoomba (on the Darling Downs); and West Burleigh (on the coast), each under a trained observer. Only three were provided for in the original plan, but the generosity of Mr. C. J. Booker permitted the establishment of the fourth station—Woolooga.

The work was carried out on similar lines at all stations, and as large numbers of ticks as possible were used, so that the results obtained might be more reliable, Every engorged female received was numbered, its date of dropping or removal from the animal noted, and the period before egg-laying began and that during which egg-laying took place were both carefully recorded—also the hatching period, the date on which larvæ began to die off, and the date by which all the larvæ of a brood were dead. No food was supplied. These experiments were carried out in tubes in shade, while a number of ticks were regularly placed in small grass plots under natural conditions, and similar periods noted.

Thus it was hoped to ascertain the various periods (maximum, minimum, and average) of the non-parasitic stages in its life cycle, and particularly to determine the maximum and minimum periods of time between the dropping of the engorged female tick and the death of its offspring which do not gain access to a suitable host.

Plots were laid down whenever ticks were available, but during winter and early spring it was commonly a matter of difficulty to obtain any at all.

The present account of the investigations is of the nature of an interim report, since it deals only with one portion of the work, viz., the non-parasitic stages in the life-cycle of the cattle tick, as observed at the various stations, Brisbane, Woolooga, Toowoomba, West Burleigh, when under field conditions, *i.e.*, in experimental grass plots.

The following table shows the minimum period (Period A) elapsing between the dropping or removal of the engorged female during the month and the earliest hatching out of larvæ from the eggs laid by it. The results tabulated are the lowest obtained from plot experiments during the period of the work (November, 1917, to May, 1919) for the particular month set down. Climatic conditions are not indicated in this report.

The paddock (if tick-free to begin with) would probably not be infective for cattle during the periods mentioned.

Under the heading Woolooga, there is included the Woolooga Hill station.

PERIOD A (MINIMUM).

—	Brisbane.	Woolooga.	Toowoomba.	West Burleigh.
January	28	29	38	17
February	23	33	38	19
March	38	30	64	31
April	42	59	No data	81
May	No data	89	No data	87
June	No data	90	No data	No data
July	70	67	No data	95
August	No data	No data	No data	90
September	No data	34	No data	49
October	No data	36	No data	37
November..	25	No data	42	26
December	36	30	No data	20

From the data collected from these four stations it was found that:—

(1) The conditions which govern tick development are fairly similar in Brisbane, and in the Wide Bay and Burnett districts (*e.g.*, Woolooga).

(2) They are more congenial in the coastal districts of South-eastern Queensland (*e.g.*, West Burleigh), and hence development may occur more rapidly—this being no doubt due to a moister atmosphere during the tick season.

(3) In the Darling Downs (*e.g.*, Toowoomba), the cold winters practically obliterate the tick, as no results were obtained from experimental plots from April until August. Ticks were not available until November. During the hot, dry weather (November to January), no larvæ were obtained from plots laid down.

(4) The most rapid development of the egg occurred in all centres in the case of ticks dropped during December, January, and February, especially during the two latter months. Thus the hot, moist conditions of a typical Queensland summer greatly favour tick development, whereas hot, dry conditions are quite unsuitable.

(5) During the winter, very few of the ticks in the plots gave rise to larvæ, and in cases where such were hatched out, there was a great lengthening of the period. Cold, then, greatly hinders development, especially when the weather is dry also, this being the common condition in South-eastern Queensland during winter.

(6) The shortest periods encountered were 17, 18, 19, 20, and 21 days (once each), all at West Burleigh. Generally, about 30 days was the minimum period during summer, lengthening to from 75 to 90 days as the usual winter minimum. In Toowoomba, the periods were greatly lengthened, except during January and February, when they approximated those of Brisbane, remaining, however, rather longer (36-60 days).

(7) A difference of one week in the dates of dropping of ticks during late autumn (*e.g.*, May) might result in a difference of some months between the dates on which larvæ would hatch out from the eggs laid by such ticks. This might happen also in the case of ticks dropped on the same date. For example, in plots laid down at West Burleigh, on 6th May, 1918, the ticks began to lay on the same date, viz., 15th May, but hatching occurred in some plots on 27th August, while in other plots it did not commence until 7th October. In spite of such differences, the various plots became clear between 24th October and 3rd November.

(8) We may say, then, that if from cattle in passing through a clean paddock in the coastal districts of Queensland engorged cattle ticks are dropped, such paddock will not be infective for from three to four weeks during summer (November to March). During the winter, the period would be two to three months (80 to 90 days). These remarks would apply also to the Northern Rivers District of New South Wales.

In Toowoomba and other districts where heavy frosts commonly occur during winter, the cattle tick appears to be at present unable to establish itself. It must then become re-introduced during the summer, when the period elapsing between the dropping of an engorged female and the emergence of its offspring from the eggs is about five weeks (minimum).

The following additional remarks regarding the detrimental effect of cold and dry conditions on the non-parasitic stages of tick may be of interest. Our winter weather, especially the cold nights, profoundly influences the life cycle, causing either the death of the eggs or contained larvæ, or else a considerable lengthening of certain periods, *e.g.*, the time between egg-laying and the appearance of larvæ hatched from such eggs. The effect depends to a considerable extent on the state of development, the majority of the larvæ dying within the shell, or whilst in the act of escaping from it.

It was observed that in some plots all the eggs (or contained larvæ) were killed by the cold, while in others begun at the same time, and influenced by the same external conditions, there was a prolonged quiescence and eventually larvæ appeared. This factor must be taken into account in any scheme of quarantine during autumn, winter, and early spring. Larvæ which hatched were commonly killed by the cold winter nights, even when the temperature was not quite cold enough for frost to be formed. There is a marked prolongation of the laying period under cold conditions, oviposition being irregular, several days often elapsing between the periods of egg deposition. Females dropped late in the autumn seek shelter and live a considerable time on the ground, egg-laying being distributed over many days. The development of such eggs either does not take place before death occurs, or else is retarded. Most of the larvæ which develop in such eggs during the winter die before emerging; but a few may survive, hatch out, and infest cattle even during the winter and early spring. Should the hatching be retarded sufficiently during its early stages until warmer weather sets in,

then the eggs hatch in number. This appears to be the normal method of over-wintering. It must not be forgotten, however, that, even during the winter, a few ticks may be found maturing on cattle, and these certainly assist in infecting the pasture.

A few warm days succeeded by cold weather, especially cold nights, are very detrimental to tick development, since the warm weather stimulates hatching, and then the larvæ (or at least a percentage of them) succumb to the cold. Larvæ appear to be very susceptible to adverse conditions during the first day after leaving the eggshell.

The following table shows the maximum period (Period B) elapsing between the dropping or removal of the engorged female cattle tick and the death of all the larvæ which hatch from its eggs, no food being supplied. It represents the maximum length of time during which an infected paddock would need to be kept free of cattle or other animals capable of serving as a host for the tick.

It should be pointed out that in many cases the figures are based upon a very small number of plots in which hatching has occurred, consequently such observations should be repeated if possible. The results given are being checked against the results obtained from ticks kept in tubes, but otherwise under natural conditions.

An assumption has also been made that larval or "seed" ticks are not introduced from elsewhere by being accidentally carried by man (on his clothing), vehicles, various animals, *e.g.*, dogs, marsupials, ground birds, &c., or by flood waters.

It is noted that, out of the many thousand larvæ which hatch from the eggs laid by the ticks in a plot, a few larvæ have a very marked longevity, being able to continue their existence for many weeks longer than the other larvæ in the same plot. The results given below include such cases.

PERIOD B (MAXIMUM).

—	Brisbane.	Woolooga.	Toowoomba.	West Burleigh.
January	171	118	150	129
February	159	133	189	163
March	141	131	185	204
April	79*	156	No data	189
May	No data	149	No data	184
June	No data	103	No data	No data
July	133	105	No data	143
August	No data	No data	No data	122*
September	No data	59*	No data	61*
October	No data	47*	No data	141
November..	73*	No data	77*	122
December	217	90*	No data	154

* Very few data available. These figures are probably low.

The total period during the summer months (November to March) was generally between four to five months in the case of Brisbane, Woolooga, and West Burleigh districts, and four to six months in

Toowoomba. During the winter, very few ticks gave rise to progeny, but when such did occur, the period was usually between four and six months in all stations except Toowoomba, where none of the eggs in the plots survived the cold.

From these results, it will be seen that a quarantine period of six calendar months should be effective, very few of the periods having been found to extend beyond that length of time.

The results obtained have led the author to form the opinion that cattle-owners in districts where the cattle tick occurs, whether sparingly or as a pest, should commence dipping early in spring (say September or early October), and continue it regularly. It is at this time that the larvæ are few in numbers, and the menace could be most easily controlled. If the ticks which have survived the winter, either as eggs or as larvæ, gain access to the host and are allowed to mature, then in a

A TYPICAL DIP (N.S.W.)

comparatively few weeks' time an enormous number of resulting larvæ are ready to infest the cattle. Cattle-owners should realize that they must dip their cattle before ticks become evident on the animals. By so doing, they will destroy the greater number of the tiny larval and nymph ticks already present on their animals, but whose small size prevents their ready detection by those in charge of the herd.

A half-yearly rotation of paddocks would go a very long way towards the eradication of the cattle tick in Queensland. Combined with systematic and thorough dipping, such rotation would, in the writer's opinion, lead to the control of the tick pest.

The Making and Improvement of Wheats.

By HUGH PYE.*

(*Continued from page* 379.)

(III.)

EVERY farmer must have noticed in every crop slight variations in the ears, and even that some plants have stood better than others after boisterous weather. Other foreign ears are noticed, but I believe less so than is the case in other countries, judging by the seed obtained from them. Thus, in the former instance, there are opportunities given for selection in the manner outlined.

The seed should be sown singly, if possible, in the rows of the stud plots. This gives better opportunities of selecting the best plants from the plots for next season's sowing.

If we take the celebrated Canadian wheat "Marquis," which is a cross between Red Fife and Red Calcutta, made twenty years ago, it owes its pre-eminence only to patient selection through the intervening years. Its weak points here are its lateness, and owing to the slight humidity of the atmosphere, its glumes or chaff are not sufficiently tough to hold its grain if the crop is left standing for the harvester. Mr. Seager Wheeler brought his "Marquis" to perfection simply by selection, and won the 1,000 dollar prize of the United States. He was a farmer, and had special training in seed selection. It may be noted that most of the great wheats of the present day owe their origin to the work of the plant-breeder, the bringing of them to perfection to the patient work of selecting. In selecting, choose the plants well within the plot or field. The outside plants are often superior in appearance, but that is mainly due to them having more moisture and plant food for the roots to work over.

Improvements of Varieties by Farmers.

If the farmer has not the inclination or time to select and grow the grain from single plants, the next best thing for him to do is to decide on the exact type of ear he believes is the most prolific and suitable, then go through the crop and select as many ears as possible of exactly similar type from good healthy plants, thrash them, grade the seed to get rid of small and shrivelled grain, and sow after pickling in a well-prepared soil. Next season, continue the process of selecting from this plot. Be sure to grade the seed well, as undoubtedly the well-matured, plump grain will give better returns than ungraded seed when drilled in under similar conditions. If it is not possible to carry out the above work, then heavily grade the seed of the general crop to get rid of any immature grain which usually is found in the ears of the secondary growth.

* Cerealist, Dookie Agricultural College.

Changes due to Environment.

Every farmer should have his own test plots, even if only two or three in number, and test the yield of his selected seed against that of his main crop. The variations in soil, the aspect of his farm, and the climatic conditions, have their influence in determining the prolificacy of the strains within a variety, on the quality and amount of gluten, on the strength of the flour made from the grain, and even on the colour of the flour, which is also a commercial asset. The milling test of a variety grown in one district varies from that grown in another, even when the seed is taken from the same bag. This, in itself, indicates the advisability, in districts where the lower-quality wheat is produced, that patient selection is needed to determine strains or varieties which though they may not have such a high milling excellence as the grain produced in the more favoured district, have the defects reduced to a minimum.

The presence of a little extra salt or other toxic substance in a soil, even in the same district, may be sufficient cause to make one variety or one strain succeed better than another, and this can only be arrived at by tests.

Prolificacy in wheat is due to a number of complex conditions, and is therefore not a Mendelian character. In the northern districts of the State, without taking into consideration the inherent qualities of the variety, it is practically measured by the evenness and proper thickness of the crop, which are dependent on the thoroughness of the cultivation and manuring, the proper seeding, the even development and ripening of the primary stems, and a minimum growth of secondary ones; also on the strength of the straw, and the absence of diseases, whether due to the climatic conditions being unfavorable, or to the inherent resistance of the variety to disease in regard to rust, and to the care in pickling as regards ball smut.

However perfect and prolific the ear may be, the qualities of the straw must be good, otherwise loss is made when harvesting the crop or should the weather be unfavorable.

The Factors influencing the Prolificacy of a Variety are, then—

(*a*) Its inherent qualities in respect to the prolificacy of the ears.
(*b*) Climatic conditions suiting it.
(*c*) Favorable soil conditions as regards plant-food, texture, and moisture.
(*d*) The inherent qualities as applied to the practical harvesting of the highest percentage of grain.

The Inherent Qualities Associated with Prolificacy are:—

(1) A well developed root system.
(2) Tillering properties suitable to the climate and soil.
(3) The number of rows of spikelets per ear, and the qualities of the rachis and glumes in holding the grain.
(4) The number of fertile florets per spikelet, with which is associated the pollen-bearing capacity of the anthers.
(5) The density and plumpness of the grain.
(6) The resistance of the variety to diseases.

(7) The strength and stiffness of straw.
(8) Flag development suitable to the climate.
(9) The constitution and vital energy of the seed and plant.
(10) The capacity of forming a maximum weight of solid matter with a minimum amount of moisture.
(11) The capacity of forming a relatively large amount of grain to other solid matter.

Each of these factors need to be specially developed according to the soil and climatic conditions of the district the varieties of wheat are grown in if the resultant grain is to be a perfect sample. Thus the heavy-flagged wheats, with their wide surfaces and sappy texture, need a long, even ripening period, which would be denied them in the northern wheat areas of this State. The evaporation from the leaves would be so great that the roots are unable to supply sufficient moisture to replace that evaporated, and though highly prolific in one country, would possibly give the lowest yields and shrivelled grain in another possessing a short spring followed by hot winds; whereas another variety with thin scanty flag would succeed well. The humidity of the atmosphere during the early summer, when the crop has ripened, is another point of consideration, since prolific varieties in climates with a fair amount of humidity in the atmosphere need not possess such holding power for the grain, enclosed within the glumes, as in the varieties suitable to hot and dry climates. Hence it is one of the reasons the great Fife wheats of Canada do not give such returns here; they shed their grain too readily before it is harvested. By cutting the crops and threshing them, this defect is more or less ameliorated.

The Best Plants, not the Best Ears, should be Selected.

It is usually thought that in selecting plants for the stud plots, the best ears are the desideratum. If it happens they are selected from the best plants it is so; but, in selecting, the primary object in view is to select the best plants, hence the reason, in the stud plots at the College, the seed is sown singly in the rows, each seed being about 6 inches apart. Thus, every plant may be studied. A few of the plants may have one or more very fine ears, and a number of sickly small ones. It is not likely they will be as prolific as the plants which have a number of good even ears on stalks of an even height and very few small ears are in evidence. Plants on the outside of the plot, and others that may be accidentally placed under favorable conditions, should, as a rule, not be chosen. In every instance the best seed of the best plants should be used. This corresponds in a measure to heavy grading when dealing under crop conditions.

What to Select.

In selecting the plants, choose those with uniform, compact, and well-filled ears possessing the greatest number of spikelets and fertile florets, firm to the touch when grasped in the hand, the glumes of a firm texture but not coarse, and possessed of a healthy glaze, which aids in throwing off excess of moisture in wet weather, and to some extent indicates greater rust resistance. The shape of the ear, in its connexion with

the weather conditions, has also to be taken into consideration. Thus, in stormy districts, the bold, broad ear offers too much surface to wind pressure; and, unless the straw is very strong, the crop is liable to be more or less lodged. In such districts the fine tapering ears lead to less loss in this respect. However, in the northern districts of this State the wind pressure, generally speaking, is not abnormal. In connexion with this, the holding power of the variety in respect to its grain should be considered in conjunction with its strength of straw. If it holds well, like Yandilla King, a strain possessing a bold tapering ear could be made. Then, again, the method of harvesting has to be considered. If the crop is cut with the binder, and ultimately threshed by the machine, it may be cut just as it ripens, and allowed to complete the ripening in the stook. In such cases, wheats like Marquis, if the other conditions are right, would hold the grain sufficiently well; but if the crop has to stand until ready for the harvester, it must hold its grain better. Having selected the plants, the ears of each should preferably be threshed separately, so that the grain may be examined. This is of special importance when dealing with varieties that are not quite fixed. It will be surprising to note the variation in the grain under such circumstances.

As regards the farmer who has established himself, and has the opportunity of carrying out a few experiments in the improvement of his seed by selection, the main considerations have been dealt with. The study of the root-systems of varieties is more difficult, and little is attempted in this direction, even in experimental stations in the Commonwealth, owing to the labour involved, and other difficulties attending the work, and the greater experimental error. This needs more expert workers. Still, the problem is an important one in its connexion with drought resistance, and actions of fertilizers; especially so should the great interior of the Commonwealth come under the plough, and there are probably millions of acres which will at no great distant future. At present this study, owing to lack of facilities, gives place to the actual experimenting with varieties to test their yielding capabilities under such conditions. Both should be carried out conjointly. Judging from the experiments I have carried out, the early maturing varieties are shallower rooted, and mature whilst there is moisture in the richer surface soil. The variations in the root structure may be as great as it is in the straw, but without special facilities and trained scientific observers this work cannot be carried out systematically.

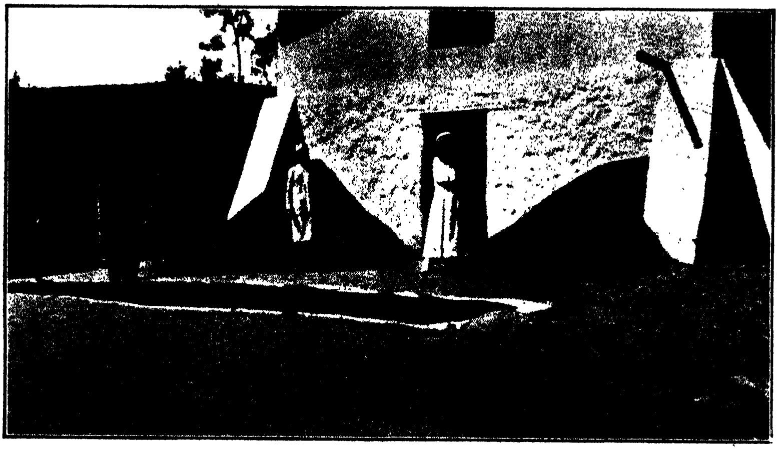
I have enumerated a number of points in which the scientific worker has helped to establish his right to every farmer's consideration.

It is this work that has added millions of pounds sterling to the wealth of his class, and when unthoughtful ones, to put it charitably, deride such work, it can only be put down to crass ignorance. I will say, speaking from my own experience, the farmers were the first to grasp the importance of wheat-breeding and improvement to the agricultural community, though it took some few years, and by actual observation of the work in the plots, to convince them it was not a fad. The work is slow, and needs patient study, and it cannot be expected that each Saturday night some new wonder has been achieved.

Utilization of Acacia Decurrens in India.

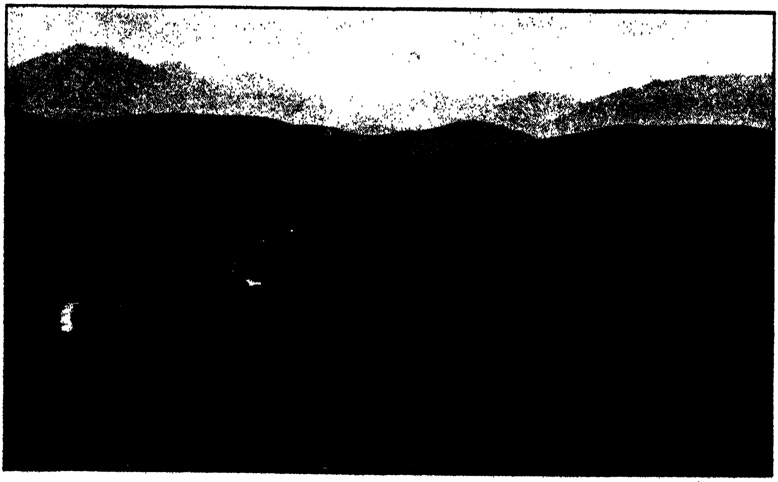
By C. E. McKENZIE, Ph.D.

It is common knowledge that South Africa is making great strides in the utilization of the Australian wattle tree, particularly of *Acacia decurrens*, for the manufacture of tanning extracts. And just as the Australian eucalyptus in California, Italy, India, and other countries finds homes which appreciate its many valuable qualities—so neglected



ACACIA DECURRENS—500 LBS. SEED GROWN ON EXPERIMENTAL STATION, NILGIRIS.

in its native country—and also to receive there the careful systematic cultivation which we so thoroughly neglect, so has our native wattle emigrated and found, chiefly in South Africa, a home where its value is highly esteemed.

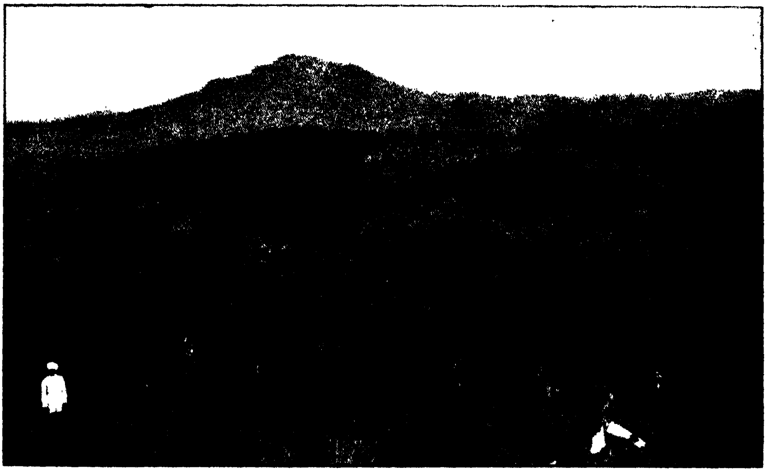


VIEW OF LAND ON WHICH THE DECURRENS IS GROWN IN NILGIRIS, ALSO SHOWING THE BIG FISHING RIVER "AVALANCHE."

UTILIZATION OF ACACIA DECURRENS IN INDIA.

I have been connected in India with an enterprise which has as its object the planting of *Acacia decurrens*, and the manufacture of its products to supply the India leather manufacturers with tanning extract, and to place on the Indian market acetic acid for the coagulation of rubber, acetone for the manufacture of explosives, and other products, such as methyl alcohol and formaldehyde from the distillation of the waste wood, and also brown paper from the spent bark.

An experimental plantation, now in full growth, of 250 acres is situated at an elevation of 6,500 feet within the tropics in the Nilgiri Hills, in South India. To insure a quicker growth, and to obtain larger areas of jungle land, new concessions of land have been obtained on the



BIRD'S-EYE VIEW OF THE NEW PROJECT, 3,000-FT. LEVEL.
New concession, Wynaad Plateau, South India.

Wynaad Plateau, 3,000 feet above sea-level, in the same latitude—11° N. The rainfall is 150 inches per annum, and the temperature ranges from 60° Fahr. to 105° Fahr. Six thousand acres have been obtained from Government free of assessments for the first five years. At the end of this period a rental is to be paid on the unimproved value. The trees will be ready for stripping at the end of five years' growth.

The method of planting is to drop two to three seeds into a hole scooped with a hoe (mamootie) 6 feet x 7 feet, or to the number of 1,000 trees per acre, at a cost of 8d. per acre (Indian labour), after a preliminary clearing of native timber at a cost of 25s. per acre. Based on the results obtained in the experimental plantation in the Nilgiris, the yield of bark will be 25,000 lbs. per acre, and the yield of wood up to 100 tons (green) per acre. The annual cost of supervision of the whole area will be £1,000 per annum.

SCIENCE AND INDUSTRY.

The following are the results of analyses of bark (No. 1), and distillation products of dried wood (No. 2) grown in the Nilgiri Experimental Plantation:—

No. 1. Leather Industries Laboratories,
London, 14th September, 1917.

Tanning matters absorbed by hide	42.3%
Soluble non-tanning matters	10.8%
Insoluble (at 60° Fahr.)	34.1%
Water	12.8%

No. 2. Indian Institute of Science,
Bangalore, 15th May, 1919.

(*Calculated on* 100 *lbs. of wood.*)

Free water in wood	7.7%
Charcoal	32.0%
Tar	9.0%
Total acetic acid	5.58%
Methyl alcohol	1.43%

The important requisites for industrial research are often unconsidered by manufacturers, who, in endeavouring to select a research chemist, are likely to regard every chemist as a qualified scientific scout. The supply of men capable of working at high efficiency as investigators is well below the demand; and chemists having the requisites and spirit of the researcher are indeed difficult to find by ones experienced in the direction of research. All research professors know that the finding of a skilled private assistant—one who possesses not only originality, but also sound judgment and intellectual honesty—is not easy, because it frequently involves the gift of prophecy on the part of the searcher. It has been truly said that the "seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them."

—*RAYMOND F. BACON.*

"The Administrator of Industrial Research Laboratories."

The University School of Forestry.

By H. HUGH CORBIN, University, Adelaide.

In the July number of the *Journal of Science and Industry*, reference is made to one of the very important combinations of science and industry, namely, forestry. In this reference, it is advocated that there should be one centre only of training for the foresters of Australia, and it is hinted only one centre, the same centre, for all research and investigation, and that it should be situated in the forest. As far as the training of many of those to be engaged in the mere routine practice of forestry, and not in the more responsible position, there cannot be a better idea than that of placing them in a good elementary school of forestry in the forest, where most of the instruction is given in the outside forest, and where proper equipment for their work in all necessary branches. and for their recreation, is amply provided.

When, however, the special training of those who are to qualify for the most responsible and technical work is considered, this type of school would utterly fail in turning out the type of forester and scientist most needed. This type of forester numerically must be relatively small.

These young men, who are prepared to devote many years of study both to the practical problems of forestry and the intricate science relating thereto, cannot be expected to derive the best training in such a place centralized in the forest, even if very large sums of money were forthcoming, say a quarter of a million, for initial expenditure for buildings, laboratory equipment, and dwellings and accommodation, and also about £20,000 per annum to provide the necessary highly-qualified staff of professors, lecturers, and assistants. To place such an institution in the " bush " would be condemning the whole *personnel* to a narrow sphere, and the inevitable result would be cramped intellects, which would reveal themselves in many ways quite well known to those who have seen such things in other places.

Surely there cannot be a better centre for the study of the higher science of forestry than the institutions specially designed for the training of those who study, say, medicine, surgery, biology, agriculture, mathematics, engineering, and such like. The argument that all forestry must be taught in the forest is very similar to saying that all engineering must be taught only in the workshops in a practical way, and that the mathematical side of the science, which can only be acquired in a quiet room in a University, is purely theoretical, and, therefore, useless to the engineer.

There is not the least doubt that the quiet study and contemplation of the practice of a science, which is done in the lecture room of a University, is as absolutely essential to those to be burdened later with very heavy responsibility in their profession in connexion with big schemes as it is for them to work practically in the science and have the problems pointed out in the laboratories as well as in the various types of forests and woodlands.

Therefore, even with the expenditure of very large sums of money, the best cannot be obtained without the assistance of the Universities in training the foresters, who would be, in every sense of the word, comparable in their professional training and ability to, say, the doctors and surgeons in medicine and surgery, and the engineers, respectively.

Apart from such considerations, the Universities are designed to give a professional man or woman an opportunity of association with those studying and qualifying in other sciences and arts, eminent persons, often of great intellect and ability. Lifelong friendships are formed in University class rooms and in sports fields and general recreations; the societies to which students belong impart such qualities that the average University man or woman can hold his or her own in the battle of life and get to know his fellow man, before being finally launched out on the world. There is little danger of a cramped mind. This is essential in those who have to hold the destiny of the forests of Australia in their power and develop them on the best possible lines. They should be the best in practice and all other ways, and well disposed towards, and conversant with the points of view of all, including the bullock-driver. Their selection should be very carefully made.

To imagine that forestry for this type of forester should be simply taught either in the field or forest alone, or only from a book in a University, therefore, is wrong. It is assumed by the writer that it is impossible to train these men unless a practical field for such training is available, in addition to more advanced University courses, but the writer is emphatic that it is immaterial whether that practical training ground is near the University or 30 or 50 miles away, provided easy communication be possible.

In any course of forestry which is to be of proper standing, the student should work for at least a year as an ordinary forest workman, doing routine work, and to acquire some knowledge of men and trees. It really is immaterial what the species or mixture of species is, for the principles of silviculture and forestry generally are the same for all species, mixtures, and conditions. It is, however, good for a student to see good forests, and as many different types as possible, and work in them. During the Univerity courses are several long vacations. These, also, should be spent in practical work in the woods of Australia, a long vacation in each of the several types, and as the student becomes more advanced the practical work should become more advanced and technical.

The fact that Australia does not possess model woods and forests is deplorable, but cannot be helped, and must be remedied; and, for the time being, one of the surest ways is to have a good University School of Forestry, or even two; but it is largely immaterial whether the forests, which must be associated with the University, are at the front door of the University, or within easy reach by train or motor.

The formation of a centre of forest culture at the University, to which men of commerce who are utilizing forest culture, and those possessing

forests and trees, can apply for information and guidance, would thus bring scientifically-trained brains into touch with the best commercially-trained brains of the community, and generally assist the primary producer, which cannot do other than good. It simply depends on obtaining the proper individuals, as in all other similar cases, to insure success.

The great advantages the Universities offer are that there is a minimum of expense entailed by grafting forestry into the University course, and political interference is practically eliminated, absolute continuity of policy and work is assured, amongst congenial and stimulating surroundings. The influence of a school of forest thought on the numerous students of other schools must have a beneficial effect on the State as a whole.

It is interesting to note that at one time in Europe and America all forestry was taught in the forest, but the isolation of these schools from other centres of culture, such as Universities, colleges, libraries, museums, botanical gardens, and such concerns as factories, timber yards, tended to make the staff and students "lop-sided" in outlook, and soon resulted in the swing of the pendulum. Now, forestry schools, where the higher training is given, are almost invariably, with one or two exceptions, associated with Universities in the centres of higher culture.

It can be shown that in the forest service of the British Empire practically all the foresters have come from some University school of forestry, which has made use of the French or German forests for a short course of practical forest training towards the end of the course, but the bulk of the actual practical work has been done in the woods of England or Scotland, in association with the hard-headed practical forester, and it is only when the students become more advanced that they can profitably put in some months in the long-established continental forests of high efficiency.

All the forestry students of the University of Adelaide who graduated in forestry enlisted, and have done active service, and some are now visiting European forests and gaining that further experience. It would be a good thing in Australia for every graduate in forestry to be allowed to visit and work in some of the forests of the old world for twelve months after completing the course in Australia, and before being admitted as a graduate to an Australian University, thus making the course after matriculation a five years' course of practical and theoretical forestry combined in the best possible way, *e.g.*:—

One year in the Australian forests as a forest workman; then

Three years in University, together with work in the forest during all vacations spent in practical work;

Finally, one year in forests of Europe on more advanced study of methods, species, and conditions.

It is now a four years' course at the Adelaide University, and if our men put in a year in Europe, it becomes equal to a five years' course.

After the student has produced a proper diary of his experiences in an approved European forest, he could then be eligible for graduation in an Australian University in forestry.

If some such scheme were adopted, we could, in Australia, be sure of obtaining good trained men who could specialize and attack the practical large-scale work and the many problems of the forest in the best possible manner. It is on such lines that we are working in South Australia, though on a small scale. The number of our students is commensurate with the scope before us. We require a few good students, not a lot of mediocre ones, in our University School of Forestry..

At present the number of those capable of undertaking research into our numerous forest problems are very few, and the field is enormous.

The student who successfully graduates cannot be expected to be widely experienced, but has the guarantee of a proper foundation in the general principles of silviculture, forest management, and a good knowledge of the general practice of forestry.

"Science has no need to blush for herself, and to-day she has begun to make her voice heard in the streets, with a force which penetrates even the dullest of ears, with a persistence redoubled by the imminent peril of the nation, and with an eloquence which neither prejudice nor indifference is able any longer to gainsay or resist."

—*Eclipse or Empire.*

Scientific Research in the United Kingdom.

By SIR FRANK HEATH, K.C.B.*

(No. I.)

THE story that I have to tell is the tale of a great adventure—one of the adventures of the great war. It was not undertaken as part of the campaign for victory in the field, but in order to help us to win the peace, a campaign now beginning and likely to be scarcely less difficult, though not as catastrophic, as the trials from which we have emerged. It was an adventure upon which the Government embarked in the summer of 1915, because, like all true adventures, it was an act of faith. The general direction of advance had been thought out, but the road was still to make, and the result was as yet invisible. The problem the Government set itself was the encouragement and organization of scientific research by direct State action. An experiment such as no country had ever attempted was undertaken by a people which, in some respects, is the most conservative in the world. We are not a nation with a finished theory of the functions and powers of government, and in that we are fortunate, for when the pressure of need arises, we are willing to take courses which a more philosophical race would shun. Our enemies, whose political theory was worked out to the last details, in confident contempt for the human nature with which it juggled, never dreamt of attempting the organization of research by direct action of the State. They were more systematic, and, to do them justice, more zealous in their pursuit of science than any other nation. They could rely upon the effects of their highly organized State-regulated system of education. But had they found themselves in our shoes, they would have discovered many excellent arguments to show the futility of attempting to organize research by State action. It would, indeed, have been an impossibility for the State as the Germans conceived it. Humboldt, in his famous unfinished memorandum to the Berlin Academy of Sciences, remarks: "The State must never forget that the achievement is not the State's, nor ever can be; it must remember that whenever the State seeks to interfere, its action is always a hindrance; it must be content to realize that the work will proceed far better without it."

Humboldt was thinking of pure research—research, that is, in Pure Science and in learning of all kinds. It is clear, from his remarks, that what we may call research in Applied Science for the purposes of industry and the practical convenience or well-being of life, was not in his mind. But it is worth while, before I go on to explain what has been done by the Government in this country during the last few years, to say something in explanation both of what is meant by "research" throughout this paper, and something about the research worker and his manner of work.

Research is a term which has been very much on our lips recently, and, as is usual in cases of this kind, it is by no means always used in one sense. The Patent Office speak of a research into the terms of previous patents, by which they mean making a search for already known and recorded facts; and the word is similarly used in many cases where the sole activity is the seeking out, the collection and collation of existing knowledge with a view to some definite course of action. Strictly speaking, this kind of work would be more properly described as "search" than a "research." At any rate, it is not the sort of work with which I am concerned. Before research in its strict sense can be begun, it may be necessary to make a search for facts already known and recorded, but forgotten or overlooked. Such action is of the same preliminary kind as seeking for paper and ink and pens before beginning to write; but it is no more research in the strict scientific sense than the collection of pens, ink, and paper is authorship. In the meaning of the term as I am using it here, research means the creation of new knowledge. It is an actual extension

* Secretary, Department of Scientific and Industrial Research, London.

of the powers and capacity of man in relation to the world in which he lives, and the extension which comes from the systematic work of the original mind upon material already to hand often takes place in a direction quite different from that which is anticipated when the worker begins his labours. That is the reason for comparing research to "the wind which bloweth whither it listeth." Discoverers, in describing the history of important discoveries, have told us over and over again of this fact—a fact so frequent and pronounced that in some cases it may almost be said that a worker has blundered upon a new truth. It is not extraordinary, because the excursions of the researcher are always into a new and unmapped country, and no man can tell until he reaches it what the lie of the land is. The more concrete the field of science, the more true will this be found to be. It is not surprising, in these circumstances, that the researcher himself should plead for freedom, and maintain, indeed, that without it his usefulness is lost. That is the central idea of Humboldt's thesis. That is why, in his view, the State must do damage by interference; and, indeed, if the State interferes with the natural processes of research work, it can only do harm. In a sense, the true research worker is an anarchist. He can recognise no laws of procedure but those of his own science and of his own method of attack. These are severe enough, and they can tolerate no external action which seeks to place him in blinkers and to force him to run at the discretion of men who cannot see with his eyes. The great question that is to be solved is whether it is possible, under these conditions, for the State to take action which will stimulate research without interfering with it, when we mean by "research" nothing but the creation of new knowledge; and whether, in the application of new knowledge to specific problems which the State in one or other of its capacities seeks to have solved, it can do anything effective towards the organization of the attack upon these problems. This second type of research does not call for the same degree of originality as the creation of new knowledge; but, on the one hand, it cannot proceed without the assistance of pure research, and on the other it is constantly revealing gaps in human knowledge which call for investigation by the pure researcher. Moreover, though much of the work in applied science is less fundamental in character, it is also, because of the large number of factors which are involved, far more complicated, and it calls for team work among researches in an ever-growing degree. But you cannot have team work without organization. To repeat my question again: Is it possible for the State, on the one hand, to encourage pure research, and on the other to organize applied research?

This, then, was the adventure. I need not spend time here in explaining why something had to be done. You know the difficulties with which we were faced. Important raw materials under enemy control, semi-manufactured products of vital importance made only by them, finished articles essential to our staple industries, or to our fighting services, drawn almost entirely from enemy sources—you know the list, and you know something of the brilliant efforts made in our emergency to supply what was missing. We have submitted to State action with a vengeance. But the Government realized that emergency measures could not offer a lasting cure for our shortcomings. An attempt must be made to organize for peace. What did they do? The traditional way of dealing with a problem of this kind is to appoint a Royal Commission of distinguished persons to study the question and recommend the action to be taken. But wise men can seldom agree to appear before the public with exactly the same answers to a question, and if the wise disagree, it becomes harder than ever to decide what should be done. Besides, time will have passed, and the problem may not seem any longer so urgent, because other problems have arisen which are clamouring for solution. Moreover, the wise men are not made responsible for carrying their advice into effect. Before anything can be done they have disappeared from the scene, and this little omission encourages argument and theory. So the Government appointed a Commission to act as permanent advisers to a responsible Minister. The Minister selected was the Lord President of the Council, because it was realized that if research was to be organized effectively, it must cover not only the whole United Kingdom, but be able to co-operate easily with possible developments of a like kind in other parts of the Empire. It was also clear that if the Government was to obtain the co-operation of the industries in regard to research, the Department concerned should be free from any suspicion of being concerned either in their regulation or in commercial dealings with them. The Minister responsible

should accordingly be unconnected with any administrative Department of the State. These considerations led naturally to the selection of the Lord President, for the Privy Council is the only Department which has relations with the whole Empire, and which is free from administrative responsibilities. Parliament voted the Minister, or rather a Committee of the Privy Council, of which he was chairman, a sum of money to spend on the encouragement and organization of scientific research—not a fixed sum, but an annual vote susceptible of increase. By an Order in Council, all proposals for spending money upon these purposes stand referred to the permanent Commission, which is called the Advisory Council for Scientific and Industrial Research; and the Advisory Council can initiate proposals of their own. It was a small but most significant change in the traditional procedure. The idea of making the Commission permanent was not new. There have been a good many permanent advisory committees to Government departments. The provision for changing the *personnel* from time to time is not new. The selection of a small body of men specially qualified to deal with the subject in hand is not new. The novel feature was the delegation of the responsibility for thinking out a policy to a permanent body of experts who are not civil servants, and making this expert body an integral part of the machine by giving them the services of the permanent staff of the Department, and keeping them continually informed of every departmental procedure. This was insured by providing them with an administrative chairman who has devoted his whole time to the work, and with a secretariat which includes the heads—instead of the junior members—of the administrative staff. In a word, the Minister, instead of relying upon his officials for advice—whether technical or administrative—supplemented by such occasional guidance upon particular questions as he might refer to temporary Royal Commissions or to permanent Advisory Committees, placed all his technical advice in commission, and intrusted it to a body of seven independent and distinguished men of science, the majority of whom were also large industrialists. The result of this experiment has been most interesting. The general policy of the Minister, and of the Government, has been worked out, not by the official, but by the Advisory Council. The Council has watched the effects of the action it has recommended, and has gradually built up a method of procedure consonant with the original intention of the Government. Stated in its simplest terms, the intention of the Government in the Order in Council establishing the new organization was that action was needed in three main directions. In the first place, research was needed in a number of directions hitherto neglected; secondly, it would be necessary to establish new institutions or to develop existing institutions for the scientific study of problems affecting particular industries and trades. And, finally, it was clear that the number of trained research workers in the country was inadequate to our needs. The information possessed by the Board of Education was clear on this point, and had led the President, Mr. Joseph Pease (now Lord Gainford), to urge the establishment of the new organization which was later set up as an independent Department. All these three main lines of action were mentioned in the original Order in Council, and proposals in regard to them stood referred to the Advisory Council. How did the Council proceed? They began, as an interim measure, by recommending the Minister to assist a number of researches conducted by scientific and professional societies which were languishing as a result of the war, and they also recommended grants to the National Physical Laboratory for an urgent research into the methods of manufacturing optical glass, and to a committee at the Central School of Pottery at Stoke-on-Trent for research into the manufacture of hard porcelain from British materials. This research has had most successful and promising results. Meantime, the Council have gradually and steadily worked out, in consultation with University professors and teachers in technical schools, with the leaders of many of our principal industries, and with each of the Government Departments, a systematic procedure along the whole front, which has not only commended itself to the responsible Minister and to the Government of the day, but has been adopted, or is being adopted, by each of the self-governing Dominions, with variations suited to local conditions, and by three at least of our Allies (America, France, and Japan).

I will divide the field of work into the three main divisions already indicated, and will deal with them, for convenience, in the following order:—(i) The encouragement of research workers; (ii) The organization of research by industries; and (iii) The organization of national research.

In dealing with each of these matters, the policy advocated by the Advisory Council, adopted by the Minister, has been that laid down by the Government when the Department was founded, viz., the delegation of responsibility for each kind of service to the expert within the limits imposed by the ultimate responsibility of the Minister to Parliament, and of the Accounting Officer to the Controller and Auditor-General.

The Encouragement of Research Workers.

The Advisory Council confirmed at an early stage the fears of a shortage in the numbers of trained research workers. The Consultative Committee of the Board of Education had reported in 1916 on the need for enlarging the output of our Universities; and more recently the Prime Minister's Committee on the Teaching of Science, under the chairmanship of the President of the Royal Society, has urged "That a large increase in the number of students passing through our Universities is a matter of great national importance." The large plans recommended by the Advisory Council for the extension of research work will increase the demand for trained workers, already inadequate for existing needs. The Research Department cannot directly insure a larger entry to the Universities and technical colleges, or assist young men and women during their under-graduate period; but it has already done something to help those who have acquired enough knowledge to begin research, or who have shown capacity for original investigation. During the academic year 1916-17, a sum of over £3,500 was spent in this way, in spite of the continued withdrawal of young men for military service. In 1917-18, the expenditure rose to £7,500, and during the current year to £10,000. Now that men are returning in large numbers from the fighting services to the Colleges and Universities, it is anticipated that over £30,000 can usefully be expended on this service during next academic year. The method of procedure adopted by the Advisory Council is as follows:—In the first place, there are no scholarships or fellowships. The grants are not honorific awards carrying titles and encouraging the competitive instinct. The amount of the grant is determined within wide limits by the circumstances of each individual case. In the next place, the applications are made upon the personal responsibility of the head of the Department in the institution to which the worker is attached; or, if the applicant is a private worker, upon the personal responsibility of a man of scientific standing, who vouches for the case and speaks as to the circumstances. Careful records are kept of the performances of workers recommended by professors and others, and the value of their recommendations is assessed accordingly. It has been found that this delegation of responsibility has worked well, much better, indeed, than the practice of leaving recommendations to Boards of students, or to the University in its corporate capacity. And naturally so, for no one knows a student or worker so well as the man with whom he has worked. Each application comes before a committee of the Advisory Council, and they make the award, after consultation in particular cases, with carefully chosen referees outside the Department. The grants made are of four kinds:—(i) Maintenance grants to students to enable them to be trained in methods of research; these grants are made for a year, but may be renewed for a second year. (ii) Grants to independent research workers devoting their whole time to research, whether in pure or applied science; these grants are also made for a year, and may be renewed for a further four years. (iii) Grants to a teacher engaged on research to enable him to employ a suitable assistant to help him in his research, but not in his teaching. (iv) Grants in special cases to a worker investigating some new branch of science to enable a research lectureship to be established in a University, pending the provision of a suitable endowment from other sources. The Department has a close working agreement with the Royal Society, who administer a special Government fund for aiding research workers, under which the two bodies work in concert, keep each other fully informed of the cases that come before them, and refer to the other those applications which appear to be more suitable for their consideration.

(To be continued.)

Colloids at Work.*

Aids to Industry.

Graham discovered that if parchment or parchment paper is stretched over a frame to make a diaphragm, that such a diaphragm or membrane will separate substances into two great classes: Those which can pass through in solution and those which cannot or only do so with great difficulty. The substances which can pass are usually capable of being crystallized, while the others are jelly-like and their solutions have properties which differ markedly from solutions of well-known crystals. A favorite experiment is to place a solution of salt and of glue in a membrane on the other side of which water flows slowly. The salt passes through into the water, and soon the glue only is to be found in the membrane-covered cell.

This principle has been applied commercially in several industries, and is variously styled dialysis, diffusion, osmosis, &c. Some crystalline substances diffuse more rapidly than others, so that certain separations can be made between crystalloids as they were originally called. Sometimes the vegetable cell itself becomes the membrane through which sugar, for example, is extracted by treating the sliced beet, in this instance, with successive changes of water. The temperature is made such that the albumins are first coagulated in the cell walls, thus facilitating the passage of the sugar solution, and then eight or more changes of water are brought into contact with the pencil-size V-shaped slices upon the counter current principle. This allows fresh water to take the last of the sugar (all but about 0.5 per cent., for it is not economical to carry the extraction below that figure) from the nearly exhausted pulp, and the juice of highest sugar content to be drawn from the first cell for purification.

In the beet sugar industry, we also find an example of osmosis using a membrane. A point is reached in crystallizing out the sugar when even impure crystals cannot be won from the residual molasses. This molasses contains above 50 per cent. of sucrose, and is unlike molasses from cane in being unsuited for human use. The sugar is recovered by precipitation with strontium of lime, or by osmosis. In the latter method, the diluted molasses passes slowly along one side of a series of membranes, and water flows in the opposite direction on the other side. A large percentage of the sugar passes through.

Within comparatively recent years, colloids have been studied more intently, and much work has been done in an effort to learn more of what actually takes place in reactions involving them. Their aqueous solutions, when pure, have the same boiling and freezing points as the solvents themselves, so the conclusion is that they are not true solutions but excessively fine particles in suspension. These particles pass through the finest filter papers, and some are too small to be seen under the microscope. The ultra-microscope enables some studies to be carried on through the observation of the shadows cast by the particles and light reflected by them. Colloidal gold is responsible for the beautiful ruby glass, and colloidal copper was used for red signal glass until chemistry pointed the way for the employment of selenium to produce that colour.

There are many who grow impatient awaiting some practical results from academic research, which seems at times to move with the speed of a glacier, and yet progress is not made without such research. How often curative medicine has been compelled to wait until a way of communicating the disease under investigation to lower animals for study could be devised. We know now how to prepare colloidal suspensions, and that will lead to many commercial applications. At least two may be mentioned as accomplished, and one of these has been developed as a result of the war.

The importance of a concentrated, easily handled, efficient fuel for war and merchant vessels is obvious, and in times of emergency, when speed and space count for most, this importance is greater than ever. A colloidal chemist conceived the idea of fortifying fuel oil with colloidal coal so fine and in such a physical condition that it would be permanently in suspension, go where the oil would, and pass through the small orifices of valves and burners without clogging them. Experiments showed the idea to be sound, and its further development will be an efficiency and conservation measure.

* Extracted from *Scientific American*.

SCIENCE AND INDUSTRY.

The extensive use of metal automobile bodies introduced a problem in lacquering and enamelling, for in order to get the required hardness and durability in the finish, it must be baked. Eventually electric ovens of great size were installed, and all went well until, in an effort to economize in the use of current, the ventilators would be closed, or partly closed, with the result that highly inflammable vapours from the lacquer and enamel volatile solvents collected in dangerous quantities in the ovens. There were fires and wild explosions, loss of work, and disturbed schedules.

This condition affected the oven manufacturers more than the enamel makers, and one of those making electric heating and controlling devices for ovens instituted research, not on the apparatus, but upon an enamel minus the expensive and troublesome volatile solvents. The problem has been solved, and the same covering materials—gums, pigments, &c.—may now be had in colloidal form in water. They cover well, bake without any material variation from the usual methods of treatment, and when once on the metal the result is the same. The ovens may be operated to suit, for there is no danger. The element of safety and freedom from property loss have been secured without increased cost, if, indeed, not without an actual saving in the expense of enamels.

And then, because the gums are in suspension and not in solution, there is nothing to make small pieces stick together. They may be put into a wire basket, dipped into the colloidal lacquer, and baked without being removed and given the individual attention necessary with other lacquers. If the metal can be heated slightly before dipping, a still better job can be obtained. There are no "fat edges," and no marks of adhering to other pieces. Such lacquers or enamels may also be brushed on or sprayed as desired.

These developments are real steps forward, and further achievements along these lines may be expected. Colloidal chemistry and physical chemistry, theoretical though they may seem, are accomplishing great things for industry, and when we begin to graduate chemical engineers well grounded in these new divisions of chemistry, still greater things may be expected.

"Scientists tell us that from Pleistocene ages onwards—a period of at least half a million years—there has been little or no change in the form and size of man's brain. Certainly during the period covered by human history—perhaps 8,000 years—there has been no apparent change in the gross anatomical structure of that organ. Yet for 7,850 of these years, taken all together, man's brain discovered and applied fewer of Nature's secrets than during the last 150 years. Discoveries and inventions are now increasing in geometrical ratio. We venture to say that nothing in any department of industrial life is being done in 1916 as effectively as it will be done in 1926. The nation which is the speediest to assimilate this truth will outstrip all others, not only in industrial, but in every other department of human activity."

—*Eclipse or Empire.*

Personal.

(MR. A. B. PIDDINGTON, K.C.)

Just about twenty years ago a trio of young men, fairly new to politics in New South Wales, bulked large in the public eye. As vigorous and uncompromising opponents of the first Federal Convention Bill, their conspicuous ability marked them out as men who were destined to rise to greater eminence in the public life of their country. They were James Ashton, Edward Davis Millen, and Albert Bathurst Piddington. The combination was generally known as the A.M.P. Popular prediction was confirmed. Mr. Ashton soon afterwards became Minister of Lands in New South Wales, but after a few years of office resigned his seat in the Legislative Assembly and entered the Legislative Council. He is widely known throughout the Commonwealth by reason of his association with and interests in the pastoral industry. Mr. (now Senator) Millen has been in Federal politics since the inauguration of the Commonwealth, and is Minister for Repatriation, while Mr. Piddington was subsequently appointed first chairman of the Inter-State Commission, a position which he still holds.

It is interesting, in the light of past events, to recall that the grounds upon which Mr. Piddington opposed the acceptance of the Bill were that the range of its authority and the constitutional adjustments as between the power of the States and of the nation in the Federal Parliament were upon too narrow a basis for the Australian union. His view was that the people of Australia were ready for a fuller union, and that there was no necessity for a Senate constituted on a provincial foundation—a Senate to represent States only—inasmuch as the States were never likely to be divided as States upon political questions.

Mr. Piddington has always taken a deep interest in public affairs, particularly of an educational character, and his official connexion with various Commissions, and his active participation in politics, has caused his name to become widely known. It was as a classical scholar, however, that he first won distinction, and although he left the serene atmosphere and environment of the University for the rough and tumble of the political arena, and later became immersed in problems of arbitration law and economics, he has always retained his affection for the classics, and has devoted his leisure to the further pursuit of his earlier studies. He is a Vice-President of the Classical Association of Victoria, President of the Sydney University Law Society, and ex-President of the Modern Languages Association in New South Wales, his interests including Spanish, Italian, German, and French.

Mr. Piddington is a son of the late Archdeacon Piddington, of Tamworth. He was born at Bathurst, New South Wales, on 9th September, 1862, and was educated at the Sydney Grammar School. Upon passing to the University, he won various scholarships, and graduated as Bachelor of Arts in 1883, winning the gold medal in classics. The following year he was appointed Vice-Warden of St. Paul's College. In

1887 he made an extended tour through Europe, and upon returning to Sydney resumed his association with the University, being Lecturer in English Literature for four or five years, and acting as Examiner in German, French, History, and English. Then the law claimed his attention, and after acting for a time as associate to the late Mr. Justice Windeyer, he was called to the Bar in 1890.

Five years later Mr. Piddington stood for the Legislative Assembly for the Tamworth electorate, and succeeded in defeating the late Sir George Dibbs. At the next election he himself was beaten. He entered keenly into the Federal controversies of 1897 and 1898, and his interest in political questions being maintained, he contributed freely to the press. Then he devoted himself uninterruptedly to the practice of his profession until 1911, when he was appointed a Royal Commission on the question of shortage of labour, and factory employment. Upon the presentation of his Report, the State took immediate steps to procure the immigration of skilled tradesmen. The following year he attended the Congress of the Universities of the Empire, in London, having been elected in 1910 to the Senate of the Sydney University. In 1913 he was made a K.C. In 1915 the University of Melbourne conferred upon Mr. Piddington the honour degree of M.A. "as of special grace."

In 1913, when the numerical strength of the High Court Bench was increased, Mr. Piddington was one of those who was appointed; but he resigned the position for private reasons only. The same year he was offered and accepted the position of chairman of the Inter-State Commission which was then being created. His colleagues were Mr. George Swinburne and Mr. N. C. Lockyer. The work which that Commission has done is well known. Upon the commerce side, the Tariff Investigation led to an exploration of all the principal trades of the Commonwealth, and the Reports which were furnished were generally regarded as a most complete statement of the pros and cons of the various items inquired into. The Report on British Trade in the South Pacific was another comprehensive survey of a new field of inquiry. Prior to the accumulation of the facts gained by the Inter-State Commission, the only information available was scattered through various publications and reports, and was of a piecemeal nature. The Report of this body represents the only official and systematic account of trade in the South Pacific that has been compiled. The Reports on High Prices were the fruit of another important investigation.

The judgment delivered by Mr. Piddington in 1915 upon a dispute arising out of the action of the New South Wales Government in acquiring the whole of the wheat crop of that State will be fresh in the memory of most people. The point of the judgment was the power of the State to acquire property within its boundaries as part of the law relating to title, and as distinct from the law relating to commerce. Through the acquisition by the State of wheat within its boundary the Government was enabled to seize wheat that was under contract to be delivered outside the State, without violating the freedom of Inter-State trade. The question at issue in the argument before the Inter-State Commission was entirely new, and various Acts of different States have depended for their validity upon the principles involved in that

decision. The judgment delivered on that occasion represents one of the few judgments on a broad constitutional question which has been upheld unanimously by a full Bench of the High Court.

Midst the exactions of his legal work, Mr. Piddington has found time for profitable recreation, and has lent his aid to various movements for national advancement. In 1916 he published a volume of Spanish Sketches, issued by the Oxford Press. They are delightful impressions of many historical cities of Spain. The same year he published a translation of Rovetta's *Romanticismo,* under the title of *Young Italy.* For this work he received the thanks of the Italian Foreign Minister; the Prime Minister of Italy having accepted the dedication. Mr. Piddington's association with the Institute of Science and Industry dates from its formation. He was appointed as one of the members of the Advisory Council, and took a leading part in the work of the Committee which was established by the original Conference in 1916, to draft a scheme for the organization of the Institute. He has continued to participate in the varied activities of the Institute with keen enthusiasm. " I am firmly convinced," he said recently, " of the necessity and usefulness of the Institute, and of the great career it is bound to have. Australia's commerce is bound to develop, but the aid of science must be invoked if our industries are to expand and develop to their full stature. In October, 1915, in their Report on New Industries, the Inter-State Commission expressed the opinion that " a Commonwealth Department, operating upon the problems of secondary as well as of primary production, might well be constituted, with a view to the systematic application of science to Australian industry."

Mr. McDonald, Chief Inspector of Agriculture of New South Wales, has been appointed a member of the New South Wales branch of the Seed Improvement Committee established by the Institute.

Mr. W. B. Alexander, M.A., Keeper-in-Biology, of the Perth Museum, has been appointed Secretary of the Western Australian Committee of the Institute, *vice* Professor Tattersall, resigned.

REVIEWS.

A Treatise on British Oil (pp. xi. + 233, 1919, with folding plates). Contributions by six specialists, edited by J. Arthur Green, with a foreword by Sir Boverton Redwood (since deceased). Published by C. Griffin and Co. It is now becoming common knowledge how oils of all kinds—animal, vegetable and mineral—were deciding factors of the war. They provided food and drugs and medicines, ammunition and power. Great Britain was especially concerned about her petroleum supplies, as she had to rely so largely on importations in oil-tankers which were subjected to such constant attacks by U-boats. Consequently, systematic survey and research were instituted to endeavour to supply British oil. Departments of Petroleum Research and Mineral Oil Production were founded, and highly qualified technologists controlled the work of chemists, engineers, geologists, colliery-owners, &c.

This book is the result of collaboration of several scientists, each a well-known specialist in his own branch of the subject, and the aim is to sum up and present the chief results of the latest researches in such manner as to render available the information that has been acquired bearing upon the one practical point—the establishment of a new industry of national importance. The authors and sections are:—

Geological.—E. H. Cunningham-Craig, B.A., F.R.S.E., F.G.S., author of "Oil Finding."

Retorting.—W. R. Ormandy, D.Sc., and F. Mollwo Perkin, Ph.D., F.I.C.

Refining.—Andrew Campbell, F.C.S.

Chemical.—A. E. Dunstan, D.Sc., F.I.C., F.C.S.

Power.—A. Hugh Seabrook, M.I. Mech. E., M.I.E.E.

Foreword.—Sir Boverton Redwood, Bart., D.S.C., F.R.S.E., F.I.C., Director of Technical Investigation H.M. Petroleum Executive.

Editor.—J. Arthur Green, General Manager Midland Coal Products Ltd., Assoc. Member Inst. Petroleum Technologists.

Such a combination should be a sufficient guarantee of the production of valuable results, and the book is a standard work of value for the whole Empire. In the appendix are the interim and final reports of the Committee on the Production of Oil from Cannel-coal and Allied Minerals, and also an outline of the work to be undertaken by the "Lignite Utilization Board of Canada." There are enormous deposits of lignite in Manitoba and Saskatchewan, and £80,000 are provided for the use of the Board. An outline of the subject-matter will be sufficient to show the comprehensive treatment of all phases of the questions which are now becoming of such vital importance to all countries.

Section I. (63 pp.) deals with oil shales in general and Cannel-coal and allied deposits, lignite and peat.

Section II. (56 pp.), on the retorting of bituminous materials, available fuels, coke ovens, low temperature distillation (20 pp.), including the Tozer and Chiswick retorts, the Maclaurin system, gas producers, and electric power schemes.

Section III. (60 pp.), products from low temperature carbonization and their chemical nature. This is an important section, and gives an account of treatment of coal by reagents, thermal decomposition of low temperature tars, the brown coal industry of Germany, chemical constitution of lignite tars and oils from shales, &c.

Section IV. (16 pp.), refining low temperature crude oils—chemical treatment, paraffin extracts, and candle manufacture.

Section V., practical experimental work—the Midland Testing Station.

Section VI., recovery of by-products from coal and the generating of electrical energy.

A process of refining Petroleum Products with liquid SO_2 is only mentioned on page 162. The Eldeanean process is described in the same author's book on Petroleum Refining. Such methods are only in their infancy, and may prove of great value. As a result of the British investigations the Midland Coal Products Company has been formed with a fully subscribed capital of £100,000 to produce oil from bituminous materials, to manufacture domestic and industrial fuels, and to deal with chemical and other by-products, testing of retorts, and other experimental work that may be deemed advisable in order to establish the industry on a commercial and a national basis. It is the intention of the company to test materials from any part of the world. The general manager is the editor of this book. Even the United States of America, with its enormous coal and petroleum supplies, does not intend to be behind in the investigations of inferior raw materials, and there is a bill in the Senate at the present time to appropriate £28,000 at once, and £14,000 for each year after, for experiments in the most economic methods for recovering oil from shale. In North Dakota there is estimated to be more lignite than in all the rest of the United States of America, and sufficient to supply billions of gallons of oil. At present there are not any oil shale works in operation in the United States of America, and most of the work of the world has been in Scotland, France, and New South Wales. Germany has recently successfully developed special methods for economically using her brown coals.

Catalysis in Industrial Chemistry, G. G. Henderson, M.A., D.Sc., &c., pp. x. + 202. 1919. Longmans, Green, and Co. A short time ago Catalytic Action was a convenient dumping ground under which many chemical reactions which were imperfectly understood were classified. It served a similar purpose as the term "physiological diseases" did in the classification of plant diseases. As a result of the numerous investigations that are now being made, especially in industrial chemistry, we see a great increase in the application of this method of bringing about chemical reactions, and the number of patents and the amount of literature are increasing enormously. Such works as Sebatier's (1913) *La Catalyse en Chimie organique*, and Effront's earlier *Enzymes and their Application* (recent English edition by Prescott), were classics in their time, and much of the present volume has been drawn from the former. There is very little included on Enzymes, as this subject is now better known by the works of Green and Bayliss, and others. This book will serve a most useful purpose in collecting much of the scattered literature, and also the patent specifications, though this could be improved by adding the name of the patentee.

The subject-matter is divided into seven chapters, each of which treats of certain related reactions. The first chapter gives a general account of the subject of Catalysis and Catalysts, and it is a great pity that the underlying principles are not now fully dealt with and the fascinating subject of metallic colloids greatly extended. The employment of catalysts enables the technical chemist to carry out a large number of manufacturing processes which otherwise would be economically impossible. Hence its great application industrially. The main chapters (2-6) cover mostly inorganic reactions; nitrogen products; hydrogenation; oxidation; and hydration, polymerisation, and condensation. The seventh chapter includes a miscellaneous group of organic preparations and processes. The actual working processes are not given, but an account in simple language of what has already been done in the field.

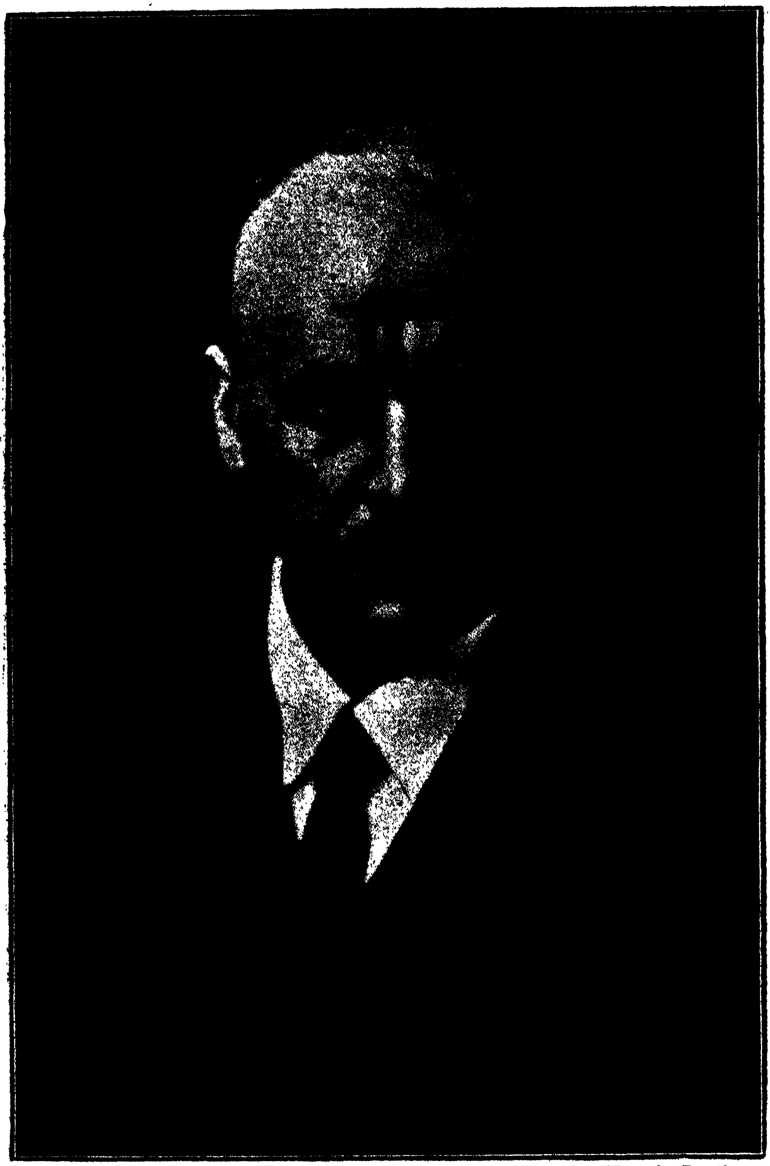
In this connexion, however, some of the better known reactions appear to have been omitted, *e.g.*, methods for elimination of CS_2 from Coulgas, and the production of NH_3 from H and N, and its subsequent oxidation to HNO_3. A section

of great interest and of ever-increasing importance is that on hardening of fats, or the hydrogenation (proper) of oils, pp. 101-110. We also find interesting information on the preparation of synthetic rubber by using colloidal Na in an atmosphere of CO_2, and the vulcanization of rubber by catalysts like glycerol (Swiss patent 1916). The table of catalysts, on p. 194, would be much improved if a list of the catalyses they produce were also added.

The book is a very readable and useful work on a difficult and obscure subject, and all students of chemistry must in the future possess a good knowledge of catalysis.

Natural Science is a subject which a man cannot learn by paying for teachers. He must teach it himself, by patient observation, by patient common sense. And if the poor man is not the rich man's equal in those qualities, it must be his own fault, not his purse's.

—*CHARLES KINGSLEY.*



[Photo. by Broothorn.

Dr. S. S. CAMERON, Director of Agriculture, Victoria, and Member of the Executive Committee of the Institute of Science and Industry.

(See page 505.)

SCIENCE AND INDUSTRY.

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EDITOR'S NOTES.

The columns of this Journal are open to all scientific workers in Australia, whether they are or are not directly associated with the work of the Institute.

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British Advisory Council.

THERE is nothing very remarkable in the fact that at the present time all the leading industrial countries of the world are giving closer attention to the encouragement of scientific research. What would be remarkable would be the adoption of any other national attitude. The quick rise of Germany and of the United States to industrial eminence was due almost wholly to their practical appreciation of the value of science as an aid to industry. It is natural that they should turn to the same source for purposes of trade reconstruction and national reviviscence, and that other countries which were losing ground should seek recovery by recourse to similar methods. The fiercer the struggle for industrial supremacy becomes the more deeply must the fountain-head of knowledge be tapped, and every new discovery must be brought to bear upon the scientific laws which govern economic production and the distribution of wealth. Science must be applied to the problems of industry, and the necessary institutions must be established in order that the economic advance may be hastened. Commonplace phrases about the importance and grandeur of science are worthless.

Great Britain, the United States, France, Italy, and Japan, did not haggle at the cost which the expansion of their pre-war facilities for research involved. They drew a clear line between retrenchment and economy. Savings are being effected in many directions, but in these countries larger sums are now being spent than formerly upon laboratories and upon scientific investigation. The one and only reason for this fresh stimulation and expansion of activity is that in the industrial arena economies must be effected, production must be increased, and efficiency must be promoted. So striking and incontestable were the achievements of science during the war that even the "practical" business man was constrained to modify his attitude toward the "blue spectacled" professor, and there is now very little opposition to the employment of the ablest scientific men available in the service of the State.

In Great Britain there are no lingering doubts about the usefulness of the Department of Scientific and Industrial Research. The latest Report of the British Advisory Council has fully confirmed the promise of rich results contained in earlier records. The creation of this institution was a war provision, and it performed such valuable service in connexion with special inquiries for defence purposes, notably the anti-submarine campaign, that its permanent establishment for purposes of peace problems was a natural and necessary step.

The work of the Department is partly direct, and partly indirect. In matters of purely national concern involving large and general questions, special branches of inquiry are instituted, whilst in matters of sectional industry co-operation is extended and encouragement is given to the prosecution of scientific research. Direct influence is exerted through such bodies as the National Physical Laboratory, the Fuel Research Board, the Food Investigation Board, and many others. The problems which these various bodies are undertaking are so far-reaching that even a partial solution of the difficulties they hold would result in enormous savings. The field of usefulness of the Fuel Research Board is practically illimitable. Various estimates have been compiled showing the monetary loss due to the prevailing methods of the utilization of coal in Great Britain. The figure has been set down by some authorities at £200,000,000 per annum, due to the waste of by-products and of heat. The importance of this inquiry lies in the fact that coal as a raw material is of service not in one industry but in all.

The late Professor Jevons, in 1863, foretold serious injury to the trade of Great Britain from the rise of prices incidental to the working of coal, and the position has now arisen owing to competition against the lower price of coal in the United States, and against its more economic use in Germany, that serious heed must be taken of the future.

The position predicted by Professor Jevons has occurred earlier probably than he himself anticipated owing to the scientific advance made by Germany. Coal has assumed a new importance and its by-products are now put to an infinite variety of uses, from driving motor cars to making scents or delicate shades of colour. Therefore, the men of science have been summoned to the assistance of British manufacturers.

Although distinct from the main lines of inquiry which the Fuel Research Board is engaged upon, it is interesting to learn that "during the year the improvements it is hoped to secure in the construction of kitchen ranges alone will save far more in the annual cost of coal consumed than is being spent each year upon all our activities."

The creation of the Food Investigation Board is another development of the highest practical importance. The main heads of its programme are fish preservation, engineering, meat preservation, fruits and vegetables, oils and fats, and canned goods. "Engineering" in this respect means cold storage, and it requires but little imagination to see the vast improvement that can be made in the conditions of life through the provision of adequate and suitable means of refrigerated transportation and storage. In Australia the study of this problem would probably be of relatively greater importance. Any advance must re-act beneficially upon all our primary industries.

The report shows a strongly increasing tendency on the part of British industries to ally themselves with the new Department, and it also shows how great is the benefit that co-operation has conferred. In the last issue of *Science and Industry* an outline of the organization and policy of the Department, given by Sir Frank Heath, Secretary of the Advisory Council, was published, and the conclusion of his description appears in this number. That outline explains the formation of trade associations for scientific research, and indicates their sphere of usefulness. The British scientific instrument makers, whose industry was substantially strengthened during the war, and is now in a better position to withstand foreign competition, have formed an association which will receive a State grant of £70,000 in five years if it raises £7,000, and carries out a scheme of scientific investigation that would benefit this pivotal industry. Science also came to the aid of the glass industry during the war period, and the glass manufacturers have allied themselves to the Department. Other associations which have been formed include the photographic industry, the cotton, linen, and woollen trades, the motor industry, and the boot and shoe trade, the iron, Portland cement, and sugar industries.

In dealing with the general principle of the organization of research the Advisory Council pointed to the danger of interference, and expressed the opinion that while it was possible for the State by means

of suitable grants to individuals, or the generous support of Universities and other independent institutions for research, to encourage the pursuit of research in pure science, it was dangerous and even fatal to attempt to organize it. Research of this nature has no other aim than the creation of new knowledge, and is impatient of the control which is inseparable from the idea of external organization. On the other hand, however, the Council asserted that "it is necessary for the modern State to organize research, which we may call investigation into problems which directly affect the well-being of large sections of its people."

In the concluding pages of the report the new activities of other European countries are broadly surveyed, and it appears that the application of science to industry is to be backed by Government funds in both France and Italy, and that research is to occupy a more important and exalted place than in pre-war days. Liberally endowed as science has been in the United States in the past, it is to be even more generously treated in the future, and a keener and closer interest is to be taken by the Government in the allocation of grants and in the trend of research.

Further information upon the aims and intentions of the British Government in regard to the scientific investigations into trade problems was afforded by the despatch of Lord Milner, a copy of which has already been published in this journal. The war brought home to British manufacturers and to the British public, with almost painful clearness, how her original supremacy as an industrial nation was threatened. The scheme of reconstruction envisages and embraces the whole of the Empire. But Great Britain's efforts must necessarily be directed primarily to her own salvation, and the protectorates and dependencies are asked to review their activities in scientific research and economic exploration, "and for consideration of all promising schemes, either for new work of this description or for adding to the efficiency or widening the scope of work already in progress."

Important as these movements are, however, they only foreshadow far greater developments. There is an insistent demand by the great thinkers in Great Britain that there shall be a colossal magnification of the scientific system of research and organization. Reports of the recent conference of the British Association for the Advancement of Science abound with allusions to the necessity of widening the scope of and multiplying the facilities for research. The establishment of the Department of Scientific and Industrial Research is everywhere warmly welcomed, but it is regarded as the first instalment and not as the final contribution of the State towards the further advancement of British industry.

E.N.R.

EDITORIAL

NEW SHEEP DISEASE IN WESTERN AUSTRALIA.

During the past two years, Professor Dakin, of the University of Western Australia, has been engaged upon an investigation into a sheep disease which made its appearance in Western Australia four or five years ago. Although he has arrived at no definite conclusion as to the nature of the disease, his inquiries point to the conclusion that it is the same as the so-called Braxy-like diseases of New South Wales, Victoria, and Tasmania, which has already caused considerable monetary loss. Professor Dakin is now on a visit to Great Britain, and in order to enable him to prosecute his investigations still further, the Institute of Science and Industry, in co-operation with the Western Australian Government, has arranged to contribute to the travelling expenses incurred. He proposes to get into touch with the Departments of Agriculture of England, Ireland, Scotland, and Norway. Professor Dakin's services, however, will be given gratuitously, and he will make a thorough study of the occurrence of Braxy in Europe.

PEARL-SHELL INDUSTRY.

Conflicting views are taken of the future of the pearl-shell industry of Australia. In the twelve months prior to the outbreak of war, Australia's exports were valued at £350,000, and in 1912 they exceeded £500,000. The preservation of the industry, therefore, is a matter of some moment. The opinion was recently expressed by a merchant interested in the trade that unless certain areas were closed, many of the beds would quickly become exhausted, and that already much of the shell now being recovered was of inferior quality. The Board of Trade recently referred the matter to the Institute for consideration, but when inquiries were instituted, it was found that no exact information was available. Mr. Charles Hedley, of the Australian Museum, expressed agreement generally with the principle of closing the beds periodically. "Luckily for the continuity of the Australian pearl fishery," he wrote, "it has never paid to lift the last ton of shell. If it became profitable to do so the beds would be stripped of their last oyster and the race would be exterminated. In practice, a natural closure is automatically effected as fishing ceases to be remunerative. It is to be noted that under these conditions a remnant of breeding stock is preserved, not from any regard for future reproduction, but merely by accident and inaccessibility. But economic conditions may change. The price of shell may rise, while the methods of collecting may improve and cheapen. Then it would pay to strip the beds closer and closer, in other words, to

make a more dangerous approach to extermination. A rough comparison may be drawn between the shelling and the timber industries. At the commencement, only the finest trees are cut. But as prices rise and facilities for transport improve, the timber-getter, if unchecked, would at last take every tree, and, planting nothing, would complete the destruction of the forest. In both industries continuity can only be assured by control. The point to be decided is whether it would not be in the interests of the State to close the beds before the poverty line is reached on the descent, and to keep them closed after the same line is touched on the recovery. The details of how, when, and where action is to be taken should be regulated by a fuller knowledge of reproduction and life history of the pearl-oyster than is yet available. In the future—but not in the life of the present generation—I anticipate that various breeds of pearl shell will be regularly cultivated. Then, but not till then, periodical arrest of work for the recuperation of exhausted beds will be unnecessary."

MARINE BIOLOGY IGNORED.

The lack of knowledge in regard to the pearl-shell industry was also commented upon by Professor Dakin, of whom inquiry was made. "So far as the Institute of Science and Industry is concerned," he advised, "I should not advise it to make any suggestions until expert information is at hand. This can only be obtained by a scientific investigation." The fact is that the study of Marine Biology has failed to arouse much interest in the Commonwealth. This one instance, however, illustrates how closely it is bound up with the practical application of science to fisheries. Professor Dakin has frequently drawn attention to the importance of obtaining wider knowledge of the marine fauna of Australia, and in particular has emphasized the necessity of studying the pearl-oyster fisheries. In his presidential address to members of the Royal Society of Western Australia in 1913, he gave prominence to the question in the following statement:—"The pearl-oyster fisheries of Australia are probably the largest and best equipped at the present time in the world. The value of pearls and pearl shell is by no means inconsiderable, and the industry is without doubt a great asset to Australia. Now there is a great danger that fishing will be conducted without any scientific supervision until perhaps some serious trouble arises, such as, for example, has arisen in Ceylon. Then, of course, a scientific investigator will be called in. This, however, is more than shutting the stable door after the horse has gone. The first thing that a marine biologist would have to do, if called in, would be to make a study of the conditions under which pearl oysters had developed; you cannot call upon a biologist as you can upon a chemist or an engineer, for problems in natural history are often peculiarly local. Besides, there are very few marine biologists with any real knowledge of pearl-oyster beds. Would it not be well worth the expenditure, therefore, as a kind of insurance, to have our pearl-oyster banks studied in detail by scientists in conjunction with pearl fishers before there is any restriction in supply? We want to know something about the enemies of the oysters on the North-west Coast, the breeding season, the deposition of spat, the cause of pearl formation, and the extent to which fishing is carried out."

EDITORIAL.

LABORATORY TESTING OF CLAYS.

The investigations into pottery clays in Western Australia carried out by the Institute of Science and Industry, in co-operation with the State Government, have created considerable interest in that State, and have provided some helpful knowledge to those engaged in the pottery industry. Mr. E. S. Simpson, D.Sc., of the Geological Survey Branch, who is a member of the Special Committee which is making the inquiries, recently delivered an address to members of the Chemical Society of Western Australia upon the "Laboratory Testing of Clays." Amongst the various properties which must be investigated in the raw state are mechanical composition, mineral composition, plasticity, air shrinkage, and tenacity when dry, and in the burnt state, colour, fusibility, shrinkage, porosity, strength, and hardness. Very rarely is it found that a single clay is suitable for any article of pottery, but from the tests carried out in the laboratory it is possible to advise as to the necessary admixture to be made to give the desired colour and body. The Western Australian Committee has already made extensive tests of local clays, and its final report on the work it has so far completed is now in course of preparation.

NEW TREATMENT OF WHEAT FOR BUNT.

As the result of comprehensive tests made at the Wagga and Cowra experimental farms, it is claimed that a more satisfactory method has been found of treating seed wheat for bunt than by pickling in a bluestone solution. Mr. G. P. Darnell-Smith, D.Sc., and Mr. H. Ross, of the New South Wales Department of Agriculture, after several years of laboratory tests and field experience, during which several mineral and other dry substances were experimented with, have come to the conclusion that carbonate of copper gives the best results. The method which they finally adopted of treating the seed wheat was to dust dry copper carbonate through the grain at the rate of 2 ozs. of the fungicide to 1 bushel of wheat. Substantial increases in the yield per acre were obtained in comparison with pickled seed, while other advantages which the new process possesses over the established practice are said to be that:—(*a*) no water is required; (*b*) no injurious effect is caused to either the grain or the young plant, as is the case with bluestone pickling; (*c*) seed wheat can be treated weeks before it is sown; (*d*) no damage is done to the grain if it should lie in a dry seed-bed for weeks without germinating; (*e*) a better germination is obtained; and (*f*) the process is quicker and less laborious than wet pickling.

BROWN COAL.

Professor David, of the Sydney University, who acted as Chief Geologist at Sir Douglas Haig's headquarters, recently visited Brisbane at the invitation of the Royal Geographical Association, and of the University of Queensland, and lectured upon his experiences at the Front. Referring to the famous brown coal deposits west of Cologne he said that in February of this year he completed examinations of the chief part of the territory occupied by the British Army on the east side of the Rhine, in the neighbourhood of Cologne, Bonn, and Solingen. These brown coal deposits occurred in seams from 50 feet up to 200 feet

in thickness, and were worked by enormous open-cast mines. The whole of the power for the working of the coal was supplied by electricity generated on the spot, the brown coal being used as fuel. The coal contained not less than 60 per cent. of moisture when mined. At one mine —Fortuna—8,000 tons were raised daily. About one-quarter of this was powdered and dried, so that the water percentage was reduced from 60 to 16 per cent., and the powder was then made up in "briquettes," under a pressure of 21,000 lbs. to the square inch. Under this great pressure the material became hot and plastic, and sufficient pitch was sweated out to cement the block together and prevent it from re-absorbing moisture. Of the remaining three-quarters one third was generally distributed locally in a raw state for household fuel purposes, and the remainder was used in generating electric power for transmission to the vast munition works at Essen, over 50 miles distant. The development of the brown coal industry, he said, was largely on account of the war. In addition to Essen, large factories at Dusseldorf, and in the area between Cologne, Bonn, and Duren, were all driven by the electric power generated at the mines. As much as 120,000 continuous kilowatts were generated at a single mine. He had marvelled at the beautiful and colossal generating machinery these mines possessed. One motor he had seen was probably the largest in the world; it was a direct turbine-driven generator, developing 50,000 continuous kilowatts. He had also seen several sets which generated 30,000 kilowatts apiece.

FUTURE SOURCES OF POWER.

Considerable interest has been aroused by the speculation indulged in by Sir Charles Parsons, in his presidential address to the British Association at its recent conference at Bournemouth, regarding the future sources of power. The passage which has evoked most comment in scientific circles reads, "The nations who have exerted the most influence in the war have been those who have developed to the greatest extent their resources, their manufactures, and their commerce. As in the war so in the civilization of mankind. But, viewing the present trend of developments in harnessing water power and using up the fuel resources of the world for the use and convenience of man, one cannot but realize that, failing new and unexpected discoveries in science, such as the harnessing of the latent atomic and molecular energy in matter, as foreshadowed by Clerk Maxwell, Kelvin, Rutherford, and others, the great position of England cannot be maintained for an indefinite period. At some time more or less remote—long before the exhaustion of our coal—the population will gradually migrate to those countries where the natural sources of energy are the most abundant." It is estimated that Great Britain possesses only 2½ per cent. of the coal still available to the world, and, in addition, that country is extracting and using her coal at a much bigger rate than most of the other countries concerned.

UTILIZATION OF EARTH'S HEAT.

In 1904 Sir Charles Parsons put forward the suggestion that borings should be sunk in the earth to sufficient depth to enable industry to make use of the heat existing below the earth's surface, and the large volumes of high-pressure steam generated there. He then suggested

that a shaft should be sunk to the depth of 12 miles. The estimated cost was set down at £5,000,000, and the time required for the work 85 years. Since then experiments have shown that the scheme is practicable. At Lardarello, in Italy, bore holes have already been made which discharge large volumes of high-pressure steam, and this is being utilized to generate about 10,000 h.p. by means of turbines. An alternative proposal is made that further attention should be given to the development of water power, and *The Engineer*, commenting upon this idea, writes:—" Living on an island against which the waves of the Atlantic and the North Sea for ever beat, and in which the variations of the tides are in many places very considerable, we see continually around us, nowhere far removed from the centres at which it would be used, manifestation of a power that exceeds the widest limits of our future needs. Difficult as are the problems connected with the development of wave and tidal power, we are convinced that they are not insoluble, and that it needs but the concentration of great inventors, coupled with the courage of great financiers, to open to this kingdom a source of power that will leave the heat engine behind, just as the heat engine itself has displaced the labour of animals and the variable force of the wind."

AGRICULTURAL TRACTORS.

A wide diversity of opinion still exists in Australia in regard to the importance of the tractor for farming operations. Tractors are gradually growing in favour, but they are used on a very small scale in comparison with horse teams. On the other hand, in the United States and in Great Britain tractors are being widely adopted. In Great Britain trials are frequent and exacting, and according to official reports these new implements are as a general rule doing what is expected of them. No general purpose tractor, however, has yet been invented. Nor is it considered likely that such a tractor will ever be perfected. For road work the machine must be heavy to enable it to get a grip on a hard and smooth surface, but weight is a disadvantage on the land, where the grip can be obtained by means of cones or spuds on the wheels. During the war, when it was essential that a very large increase should be made in the acreage under cultivation, the British Government, because of the inability to secure horses, took steps to purchase every tractor of almost any make that was available. Naturally the initial difficulties in getting them to work were enormous. Inherent defects in many of the machines, the scarcity of trained engineers, and the absence of spare parts were only a few of the handicaps. Yet the tractors solved the food problem.

ADVENT OF THE TRACTOR IN GREAT BRITAIN.

Although the whole project was one huge experiment, and its cost was justified only by the seriousness of the food situation, yet it is considered likely that the experience gained from this wholesale employment of mechanical traction will compensate for the outlay. The *Journal of the Royal Agricultural Society of England*, in commenting upon the work, states that " the experiment has almost revolutionized our English methods of farming, and in no other way could mechanical power have

been so thoroughly tested, improved, and generally accepted in so short a space of time." It is stated that the trade in agricultural tractors is increasing daily, and that there is scarcely a farmer occupying 200 acres or more of arable land who has not already begun to consider whether it would not be to his advantage to become the owner of a tractor. It is admitted on all hands, however, that tractors possess some defects, and that perfection is far from having been attained. One authority estimated that within three years 50,000 tractors would have to be supplied in the United Kingdom alone. An interesting point is made that owing to the greater amount of work done by tractors it was possible to employ a better class of man on farm work, with the collateral result that occupation on the land became more attractive.

LARGE GRANT FOR INDUSTRIAL RESEARCH IN UNITED STATES OF AMERICA.

The Bureau of Standards at Washington has received for the current financial year a special grant of £85,000 for standardization work and technical investigations in connexion with secondary industries in the United States of America. The sum is to be expended as follows:—Industrial research, with a view to assisting in the permanent establishment of American industries developed during the war, £50,000; testing Government materials to determine suitability for the specific uses involved, £20,000; industrial safety standards, £5,000; standardization of instruments, machinery, and equipment, to enable the Bureau to co-operate with engineers, manufacturers, and the Government Departments, £10,000.

The Director of the Bureau states that the need of co-operation with industries has gone far beyond his expectations. There never was a time in the history of the country when the industries were in such great need of this work. They are introducing scientific methods. They are called upon to produce all sorts of equipment and all sorts of material, in many of which the fundamental and underlying investigations required are the same. The demands by the industries on the Bureau have increased tenfold since America came into the war. During war-time the industries were compelled to do things in a different way than they did before. They had to get substitutes for many materials, and there has been a tremendous awakening as to the value of scientific work. The industries are willing to co-operate, and for every dollar the Government puts into the work the industries will put in 1,000.

GOVERNMENT PAPER PLANT FOR NEW SOUTH WALES.

The New South Wales Government intends to undertake almost immediately experiments in the manufacture of paper from local timbers. A Committee, consisting of Mr. W. A. Gullick (Government Printer), Messrs. R. T. Baker and H. G. Smith (of the Sydney Technical College), and two other Government officers, is now arranging for the introduction of a plant into New South Wales. This action has been taken in consequence of the satisfactory reports received from Canada of laboratory tests of the suitability of selected Australian timbers.

EDITORIAL.

DESTRUCTIVE CITRUS DISEASE.

Considerable damage is being caused in one or two citrus-growing districts in New South Wales by the prevalence of Black Spot, which attacks mandarines. It is attributed to the fungus *Colletotrichum glœosporiodes,* and is not to be confused with *Phoma citricarpa*, which gives rise to the Black Spot of the orange. Some inquiry into the subject has already been made by the Biological Branch of the New South Wales Department of Agriculture, and although a treatment has been prescribed, it has been found in practice that it is too severe, and markedly affects the vitality of the trees. Additional experiments, therefore, are to be carried out by the Department, and the results of the further investigations will be watched with a good deal of interest. Fruit-growing is becoming of so much greater importance in Australia than it was a few years ago, that exhaustive inquiries into some of the principal diseases which affect not only citrus but other fruits should be undertaken.

TESTS OF PINE TIMBERS.

Tests of pine timbers, carried out by Professor R. W. Chapman, of the Adelaide University, point to the superiority of the Canary Island Pine (*Pinus canariensis*) over both the Remarkable Pine (*Pinus insignis*) and the Maritime Pine (*Pinus maritima*). Several hundred tests of the timbers were made, and the outstanding feature of them all was the great strength of the Canary Island pine as compared with others. Taking the average weight of all the beam tests, a beam of this timber 12 inches by 12 inches and 12 feet long will carry a central load of about 42 tons before it breaks. An Insignis beam of the same size will carry 24 tons, and a Maritime 19 tons. Oregon beams of the same size will carry 26 tons. Similarly, a short column of Canary Island pine 12 inches by 12 inches will carry a load of 533 tons before it actually breaks. Insignis will carry 297 tons, and Maritime 336. Canary Island pine flourishes in 18 to 20 inches rainfall areas, and better still in heavier soils in the 20 to 25 inch rainfall areas. It is a tree that is particularly free from disease, and yields an extraordinary amount of resin and turpentine. It is about 15 per cent. slower in growth than the Insignis, but when drought is killing the latter it is flourishing. Moreover, it is not readily destroyed by fire, as it will sprout again.

STANDARDIZATION IN GREAT BRITAIN.

Before the war the United States was far ahead of Great Britain in standardization and specialized machinery. The American clock and the Ford car are two well-known examples. Professor J. E. Petavel, in an address to the engineering section of the British Association, pointed out that during the war Great Britain adopted and developed similar methods. As a result, although the result of all materials increased considerably, although the wages more than doubled, and although the profits made were more than adequate, the cost was in many cases reduced. Thus the 18-pounder shell fell from 22s. to 12s., and the Lewis gun from £165 to £62. Professor Petavel stated that the importance of standardization had now been fully realized by the manufacturers of Great Britain, and as a result a general reduction in cost was expected.

RESEARCH ON TIN AND TUNGSTEN.

An important report has been published by the British Department of Scientific and Industrial Research on the work of the Tin and Tungsten Research Committee. A research on slime treatment on Cornish frames by Professor S. J. Truscott and others has, it is considered, settled a number of the conditions governing frame working, and the result of the tests is to suggest the advantage of modification of two fundamental factors in policy, in the shape of rapid enrichment of slime, instead of the present practice of gradual enrichment, and extended fine grinding. In this way, Professor Truscott believes that an increase of 11 per cent. of the present recovery of tin would be gained.

The treatment of complex low-grade refractory materials, such as "tinny iron" or "black iron," by fusion with nitre cake has been investigated by Mr. H. R. Beringer, Captain A. M. Drummond, and Mr. F. H. Michell. They found in the laboratory that by fusion at a red heat and treatment of the melt with water, the iron and tungsten passed in great part into solution, while the cassiterite remained in the residue in a suitable condition for recovery on the dressing floors. Promising results were obtained in an experimental furnace with a flat cast-iron bed at the King Edward Mines, and the management of the South Crofty Mine decided to utilize the process in a larger furnace of different design. There seems reason to expect that the remaining difficulties will be overcome, and that the nitre cake process will become available for treating refractory complex low-grade concentrates which at present realize little or nothing, involving a loss of many thousand pounds annually in the country.

The same investigators have been endeavouring to find a chemical method of removing and recovering the tungsten from concentrates as they leave the calciner, and from certain ores containing wolfram. They have had most success with a modification of the Oxland process, but it does not at present appear that the method can be used industrially. Dr. O. J. Stannard has succeeded by a new process in separating tungstic acid in a remarkably pure form from concentrates and wolfram ores. In experiments by Mr. H. W. Hutchin, assisted by Mr. L. J. Meade, on the recovery of tungsten from concentrates by digestion with caustic soda, dilute solutions were found to be ineffective. Strong solutions acting on uncalcined material effected what was apparently complete extraction of tungstic oxide, but the extraction from calcined material was incomplete, and economic success appears unlikely.

AUSTRALIAN SANDALWOOD OIL.

It has been found that there is a marked chemical difference between the oil derived from Western Australian sandalwood and that obtained from Indian sandalwood. The most important result of recent research was to show that the oil from the West Australian tree did not contain santalol, but a nearly related chemical compound. Medical practitioners who have used the Australian oil consider that it is quite equal to the true sandalwood oil for medicinal purposes without possessing the deleterious effects of the latter. The subject has been referred to the Institute by the Western Australian Committee with a view to having complete tests made in respect to the chemical and therapeutical properties of the oil, so that action might be taken to have the Australian product inserted in the *British Pharmacopœia.*

EDITORIAL.

THE EMPIRE'S FLAX INDUSTRY.

An interim report by the Empire Flax-growing Committee on the general situation of the flax industry, and the immediate prospects of supply, strongly emphasizes the importance of the industry to Great Britain and the necessity for sustained effort to foster the revival of flax-growing in Great Britain and extend its cultivation within the Empire. The efforts made under stress of war conditions were directed mainly at determining whether under modern conditions, including the use of machinery and the central retting process, it was possible to re-establish the industry on a sound economic basis. The Committee recommends that research should be undertaken into the possibility of further mechanical improvements in the means of cultivating and handling flax. The programme suggested for Ireland includes, *inter alia,* permanent provision for the training of instructors and scutchers, and loans for the erection and repair of scutch-mills. In British East Africa the results already achieved warrant the hope that that success in this arena is likely to be permanent.

LINEN INDUSTRY RESEARCH ASSOCIATION.

A Linen Industry Research Association, organized by the Department of Scientific and Industrial Research, has already been formed, with Dr. Eyre as Director of Research, and Belfast as headquarters. All departments of the linen industry are represented on the Board of Directors. At the inaugural meeting the range of investigations was only hinted at, but the improvement of seed by selection was regarded as of initial importance. At present the position of fibre flax seed is one of the greatest confusion. Long habit and short, coarse and fine, early maturing and late, are hopelessly mixed together. One authority stated his belief that it should be quite possible to have one variety of flax producing fine weft, another medium warp, another heavy warp, and so on. The utilization of waste products was another problem. Dr. Eyre pointed out that there was clear evidence that inequalities in the raw material for spinning was responsible for much of the trouble experienced in the after-processes. The work would be mainly on the agricultural side, but would reflect through nearly all subsequent stages of the industry, particularly the spinning end. Apart from work of that kind, certain problems associated with bleaching must be approached, and a careful study must be made of the problems associated with the artificial drying of yarns. Mr. R. Garrett Campbell, Chairman of the Irish Committee of the Flax Control Board, warned members of the Association against expecting substantial results for many a day, and reminded them that they were only commencing to work towards results which eventually would undoubtedly appear in their balance-sheets.

GEOGRAPHY A PRACTICAL STUDY.

A plea for the teaching of geography on a higher plane in Australia was made by Professor David, of the University of Sydney, during a recent visit to Brisbane. He described how in the United States settlement had been increased greatly under the most favorable circumstances by studying propaganda work through all the Government Departments, the schools, technical colleges, and universities. What

wonderful things could be done in the way of adapting our population to their environment if we had better and more reliable information about the climatic zones of our country, about what kind of animal and useful plant-life could be introduced, and how we could combat noxious plants and weeds. He also spoke of the difficulty of making people in Australia understand what wonderful work had been done in the United States in the way of preserving fodder in ensilage. The practice is now a marvellous success from the Atlantic to the Pacific. Professor David expressed the hope that the University of Queensland would keep the teaching of both geography and geology in close touch with the survey work of the Lands Department, with forestry work, and with farm experimental work. For defence work the thorough study of physical geography was of the greatest national value.

BLOW-FLY EXPERIMENTS.

Experiments being carried out by the New South Wales Government in co-operation with the Institute of Science and Industry into the blow-fly pest in the pastoral areas have progressed sufficiently far to indicate valuable lines of investigation. Writing to the Institute recently, Professor J. Douglas Stewart mentioned that he had just visited the new experimental station at Warrah, near Quirindi, which had been established to test in a practical manner the results obtained by Mr. W. W. Froggatt at Moree. These preliminary inquiries went to show that the blow-fly could be suppressed by destruction of its breeding places and the trapping of adults. At Warrah, therefore, a rectangular area has been selected, approximately 5 miles by 3 miles, and comprising about 10,500 acres of alluvial plain and timbered ridge country. A creek runs through the property. Throughout the area about 100 traps have been set out about half-a-mile apart, each being numbered. The traps are to be inspected once a week, and the catch recorded. Meteorological records will be kept, as well as, for the purpose of comparison, records of the prevalence of the blow-fly in adjoining areas. Owing to the prevailing drought the experimental area is now but lightly stocked with sheep, and consequently the destruction of existing offal, carcasses, &c., should be effectively carried out by the assistant in charge, while the spraying with arsenical solution of recent carcasses will, in the opinion of Mr. Froggatt, cause them to become auxiliary fly-traps, and also prevent flies breeding in them. Should this test prove successful and the cost not prohibitive it will be possible for the stock-owners, by adopting similar methods, to avoid the handling, crutching, and treatment of sheep during the fly seasons, and thus effect a considerable saving in time, labour, and expense.

BREEDING CHALCID WASPS.

Such scientific research as was carried out at Moree did not indicate the possibility of any easy way being discovered to effectively deal with the blow-fly pest, such as dissemination by disease artificially distributed. The chalcid wasp, however, was bred in large numbers there, and has been widely distributed. The accruing benefits as an auxiliary means of suppression are favorably reported on from many centres. The breeding of the wasp has now been transferred to the State Experimental Farm at Glenfield, near Sydney. Unfortunately, owing to the

shortage of funds no scientific investigation is now in progress. Commenting upon this fact, Professor Stewart states, "The establishment of the permanent Institute with its full Scientific Staff would no doubt have solved this and other difficulties." It is generally recognised that sick and weak sheep are prone to suffer severely from blow-fly attack, and some members of the Special Inquiry Committee are desirous of having scientific inquiry made as to the possibility of fortifying such sheep by the administration of medicinal licks. It is known that the general health of sheep can often be improved by the allowance of salt combined with certain medicaments, but no precise knowledge is available as to the best combination for the different districts of the State. As the funds made available by the Institute are almost exhausted, the question of further subsidizing the State expenditure will shortly be considered by the Executive Committee. Elsewhere in this issue is published the report of the investigations of the Queensland Blow-fly Committee, and important recommendations are made for the treatment of sheep in mitigation of the pest.

RAILWAY TRANSPORT *VERSUS* MOTOR LORRIES.

In the July issue of the *Engineering News Record* a special report is given on the relations of the railway and the road as a means for economic transportation. The report shows that this question is not capable of a single answer. The problem must be studied and solved by engineers for each individual locality. At the same time it is pointed out that there is a widespread belief in the U.S. America that the good road and the motor lorry are destined to supersede the light traffic railway. The motor lorry for freight transportation is now carrying on a lively competition with the railway in handling freight on many roads. While the building of branch-line railways is at a standstill, the construction of good roads is proceeding on an enormous scale. Loans of £10,000,000 and £12,000,000 for good roads have been approved in Illinois and Pennsylvania respectively, and other States are following into line. It is agreed that roads must now be built heavy enough and costly enough to withstand motor lorry traffic.

SYNTHETIC NITROGEN COMPOUNDS IN GERMANY.

Lieutenant R. E. McConnell has recently inspected the Haber plant at the Oppau works of the Badische Soda u. Anilin Fabrik, near Ludwigshafen, on the Rhine. As the Germans raised strong objections to detailed examination, he was only able to spend three days at the factory, and was not permitted to view the plant in actual operation. During the year ended 1st November, 1918, this plant produced 90,000 long tons of fixed nitrogen, *i.e.*, its capacity was equal to one-fifth of the total 3,000,000 tons of nitrate supplied by Chile to the entire world during the same period, and ten times that of the Haber plant installed by the U.S. Government at Sheffield, Alabama. If to this output be added the reported production of 125,000 tons at a factory near Halle, the combined output would be equal to one-half that of the total supply from Chile. It has been officially stated in the Reichstag that 400,000 tons of combined nitrogen was produced in Germany in 1916. However this may be, it seems certain that Germany is capable of exporting

nitrogenous compounds in amounts approximately equal to her pre-war consumption of 750,000 tons of Chilean nitrate. The producing capacity of the Oppau works at the present time is estimated to be:—

Oppau Plant.		Tons per annum.		Tons combined Nitrogen per annum.
Ammonium nitrate	..	10,000	..	3,450
Sodium nitrate ..	..	130,000	..	21,410
Nitric acid (100 per cent.)	..	40,000	..	8,890
Ammonia (liquid)	..	40,000	..	32,900
		Total ..	..	66,700

The cost of the plant is stated to have been between £5,000,000 and £10,000,000; to-day a similar plant would cost at least £13,000,000. The *personnel* of the factory comprises 1,500 labourers, 3,000 mechanics, 350 clerks, and 300 chemists. The daily consumption of fuel is 1,750 tons of lignite, and 500 tons of coke, and the total cost per diem is about £11,000, including allowances for depreciation, &c.—(*J. Ind. Eng. Chem.*, Sept., 1919.)

A SHIPMENT OF POTASH.

In the October number of *Science and Industry* Dr. Heber Green, in an article on the available sources of potash, referred to the rich deposits of Strassfurt salts in Germany, and quoted a newspaper statement to the effect that a shipload from that centre has already arrived in Australia. Messrs. Dalgety and Company, the agents, have explained that the shipment referred to is not German potash, but comes from Alsace, which territory, of course, has now reverted to France. As part payment of her war indemnity, Germany is being allowed to export potash from Strassfurt to Great Britain.

KIMBERLEY DISEASE IN HORSES.

The West Australian Committee of the Institute of Science and Industry is interesting itself in the Kimberley disease of horses. From reports received from the Western Australian Department of Agriculture, the Aborigines Department, and the Commissioner of Police, it appears that in the West Kimberley region about 30 per cent. of the total number of horses die from the disease every year, whilst in the East Kimberley region the mortality percentage from the same cause is about five or six.

INDUSTRIAL ALCOHOL.

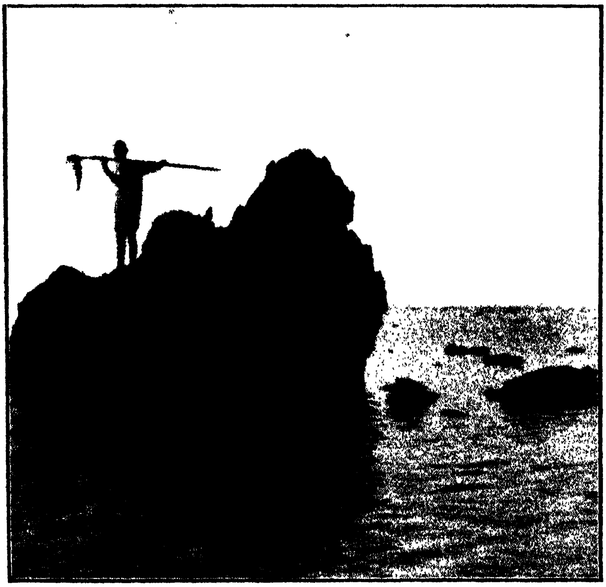
In the September issue of the *Journal of the Society of Chemical Industry* attention is directed to the fact that in the U.S. America breweries are gradually finding new uses, the latest to report having become a modern macaroni factory. Meanwhile a fight is being waged to secure relaxation of the regulations so as to permit of the use of tax-free alcohol in the industries. Alcohol is quite important, if indeed not essential, in the production or refining of some 150 materials in industrial chemistry and pharmacy, to say nothing of its use in producing light, heat, and power. Several recent experiments with alcohol as a motor fuel, even in aeroplanes, have yielded results encouraging to those interested in its use.

The Harvest of the Tropic Seas.

By CHARLES HEDLEY.

Where soil is good and rainfall ample, the product of the earth depends on temperature, becoming richer as the climate grows warmer. Naught but moss and lichen is afforded to the hardy reindeer by the desolate hills of the Arctic, while the fields of the tropics produce spice and sugar, oil, breadfruit, and bananas. The maximum of human food per acre is obtained in the equatorial zone.

But this rule does not apply to the sea. The most fish, the best fish, the largest fish occur in the cold latitudes of Norway, Scotland, Iceland,



NATIVE STANDING ON "NIGGERHEAD."

and Labrador. The herring and the cod supply more human food per sea mile than any other fish. On the reverse side of the globe, it is recognised that fish are more abundant and of better quality in New Zealand or Tasmania than in Australia.

The reason of this has not been fully explained; probably it is due to the relative abundance in warmer waters of bacteria which consume nitrogen. The activity of these unfriendly bacteria would starve the plant life of the sea, and by so much the plant diet of fishes would be reduced.

But though as a source of food for fishes the tropical seas are inferior to cooler waters, they provide humanity with many desirable gifts. The warm, shallow, island-studded seas that fringe the shores of

tropical Australia may in the future support a large resident population of fisher folk. At present its resources are exploited by an alien, coloured, and nomadic host.

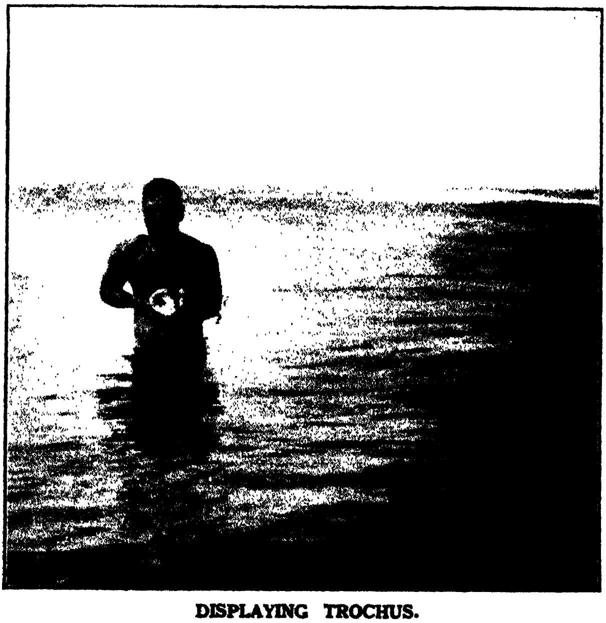
Pearling, or shelling as it is locally called, is the most important of the marine tropical industries. The pearling grounds extend for more than 2,000 miles along the northern coast of Australia. Here, in 1913, were employed 4,000 men, the product of whose labour was valued at £444,000. As a business, pearling began in Western Australia in 1861, but the beds of Queensland were not worked till a few years afterwards. Not until 1881 had the fishery grown sufficiently important to attract the attention of the Government. In that year various regulations, such as licences for boats and divers, were instituted. About ten years afterwards the law forbade the taking of immature oysters, placing on "chicken shell" a limit of a diameter of 6 inches. From time to time all the beds have been exhausted by over-fishing, but they have recuperated after a few years' rest.

COLLECTING ON REEF.

Three kinds of pearl shell are fished in Australian waters—the Golden-lip or Silver-lip, the Black-lip, and the Shark-Bay shell. Of these the Golden-lip (*Pinctada maxima*) is the largest, the most lustrous, and therefore the most valuable in the world. It occurs north of Townsville, on the Queensland coast, round to Exmouth Gulf on the west. In the early days of the industry, when oysters might grow to their full natural size, the shell often attained a weight of 6 or 7 lbs. a pair; now 2 lbs. are considered a fair marketable shell. Having such brilliant nacre, this species forms beautiful pearls. But as a pearl is the consequence of disease, it more frequently occurs in stunted and misshapen shells. The staple of the industry is the mother-of-pearl,

the oyster shell itself. This is exported for manufacturing into knife handles, buttons, and articles of jewellery. So difficult is it to control the gathering of the pearls that they are regarded merely as an incident in the business, and are sometimes granted as a perquisite to the men. The shell, as soon as it is taken, is opened on the deck with a knife, and any pearls that it may contain are scratched out with the fingers from the flesh in which they are embedded.

Originally the shells were picked up from the surface of the coral reef by wading at low tide. When this situation was exhausted, natives were engaged to dive for the shell in shallow water. By degrees shell was followed down to water too deep for a swimmer to operate, and diving dresses were then introduced. The usual depth from which shell is procurable is 7 or 8 fathoms. Exceptional depths up to 20 fathoms may be reached, but work at such levels is difficult and dangerous. So heavy a mortality was caused by shelling in deep water that it was disallowed by regulation.



DISPLAYING TROCHUS.

Proposals were made to cultivate the pearl shell, but the experiments attempted have not yet been a commercial success.

The head-quarters of the Queensland pearling fleet is Thursday Island, whence the vessels radiate to Torres Strait, New Guinea, and the Great Barrier Reef. The corresponding capital on the west coast is Broome.

The Black-lip shell (*Pinctada margaritifera*) has a much wider range, both within and beyond Australia, than the previous species. But it is inferior both in size and in the quality of nacre and pearls.

The Shark-Bay shell (*Pinctada carcharina*) is quite different in habits and appearance to either of the others. The shell, scarcely 3 inches in diameter, is thin and poor, and can only be used for inferior

goods. It grows in thick clusters, and is gathered with rakes and dredges. The animal is torn from the shell and thrown in masses into barrels to rot. After putrefaction has softened the decayed mass, the pearls it contained are sieved out.

Less profitable than pearling, but requiring less skill and capital, is the bêche-de-mer industry. In 1913, the Australian crop was worth £30,000. The trepang, or bêche-de-mer, is a soft slug, which as an article of food would generally be considered to be of repulsive appearance. The shape is that of an enormous cucumber. It can contract and expand, is covered with rough-looking, but soft, warts, and is mottled with various colours—red, brown, orange, or purple. The head end puts out a whorl of tufted feelers, which procure food by sweeping together sand and microscopic organisms, and thrusting the mass into its mouth. Some kinds have the unpleasant habit of voiding their viscera when handled, thus earning the name of "cotton-spinners."

CORAL REEF AT LOW TIDE.

About twenty different sorts have been observed in Queensland, but of these only those which have a firm flesh are esteemed of commercial value. The choicest varieties are known in the trade as the Black-fish, Teat-fish, Surf Red-fish, and Red Prickly-fish.

It is curious that young specimens are never seen; the bêche-de-mer appear to spend their earlier life in deep water, and to ascend to the level of low tide only when full grown.

The fishing is often conducted by a fleet, of which the smaller vessels forage for supplies and a larger one deals with the harvest. Coloured labour is usually employed in collecting. The natives gather the fish by hand, wading over the reefs at low water or diving in the deeper

water. The first process in manufacture is to boil the fish in large iron kettles for twenty minutes. Each is cut lengthwise, the inside emptied out, and the husk placed in the sun to dry. Afterwards the flesh is smoked for twenty-four hours. When hard and dry it is ready to be exported to Hong Kong. As any moisture would now ruin it, much care is exercised to keep it free from damp.

A taste for this dainty is being acquired in Australia, and in the hotels of North Queensland bêche-de-mer soup is a frequent and much-appreciated dish.

So far, little attention has been given by business men to Australian sponges. The sponges hitherto obtained in Queensland have been hard and low-grade, though useful. It is likely that exploration would discover valuable and high-class sponges in our waters. Good sponges would be likely to occur, not at the surface, but at some depth, thriving in clear and warm water.

The sponge of commerce is a skeleton, from which the flesh has been stripped. When alive—for a sponge is an animal—it rather resembles a piece of cow's liver. Usually it encrusts a piece of rock or shell, and derives its nourishment from water that percolates through its substance.

The off-shore waters of tropical Australia teem with several kinds of turtle, the best-known of which are the Green and the Hawks-bill turtle. It is the Green turtle that provides the turtle soup of aldermanic banquets. It subsists on seaweed, and reaches a yard in length and 1 cwt. in bulk. The so-called "tortoise-shell" of commerce is derived from the large, overlapping scales of the carapace of the Hawksbill, which is smaller than the Green turtle, and of carnivorous habits. In the spring female turtles land on the beaches of unfrequented islands to lay their eggs in the sand. While thus engaged it is easy to catch and slaughter them. At present, difficulty of access to these remote and waterless islands invests the breeding places of turtles with a natural protection; but when population increases and meat becomes more valuable, it is likely that these nurseries will be so methodically raided that the breed will be exterminated.

Macrozamia Spiralis as a Source of Industrial Alcohol.

By GEORGE HARKER, B.Sc. (Syd.), D.Sc. (London).*

I.—General.

Macrozamia or the Zamia palm (known in New South Wales also as burrawang or native pine-apple) is a gymnosperm belonging to the Cycad family. There are two main species common in Australia. These are *Macrozamia spiralis*, of New South Wales and Queensland, and *M. fraseri*, of South-west Australia. In New South Wales, the palm grows usually to a height of 2 or 3 feet, with a stem 1 or 2 feet in diameter. The Western Australian species is decidedly stouter than the eastern, and in exceptional cases attains a height of 10 or 12 feet. The plant chiefly occurs in poor land of little value for agricultural purposes, but is equally at home in damp low-lying soils and on stony hillsides. In such localities in the coastal regions of both New South Wales and Western Australia the plant often forms a dominant element of the vegetation. Many thousands of acres are covered by it, for example, in the vicinity of Nelligen, near Bateman's Bay, and in the Kincumba district, near Gosford. In Western Australia it is very plentiful along the south-western railway line, almost all the way from Perth to Busselton, a distance of about 130 miles, whilst it also occurs in great abundance on the western slopes of the Darling Range.

In connexion with the work of the Special Committee appointed by the Institute of Science and Industry to investigate the question of the manufacture and use of power-alcohol, it was considered desirable to inquire into the possibility of utilizing macrozamia as a raw material for the manufacture of alcohol. The investigation to which this report relates was accordingly undertaken primarily for the purpose of determining the amount of alcohol yielded by *Macrozamia spiralis* collected in different districts of New South Wales at different stages of growth, and at varying periods of the year. It was also desired to obtain information regarding the amount of starch present in the plant. It was decided to examine the outer, as well as the inner, core of the bulbs, as, up to the present, only the inner core has ever been treated. This entailed twice as much work, but the results obtained more than justified the expenditure of the extra labour. By arrangement with the Forestry Commissioners of New South Wales, samples of macrozamia were collected from different localities in the State, and at different times of the year. These were sent to the Sydney University, where the investigations were carried out on behalf of the Institute of Science and

* Department of Organic and Applied Chemistry, University of Sydney. Member of Special Committee of Institute of Science and Industry on Power-Alcohol.

Industry. The bulbs always arrived in excellent condition, and grateful acknowledgment is made to the Forestry Commissioners for their valuable assistance in providing the raw material.*

On arrival of a batch of bulbs at the University, the leaves were stripped, each bulb being weighed, the outer core removed and weighed, and the weight of inner core obtained by difference. The outer and inner portions were separately ground, first through a coarse sieve and afterwards through a fine sieve. The material was then sampled, and several pounds weight were thoroughly air-dried and kept for the chemical investigation. The loss of moisture on air-drying was determined on a kilogram portion. The material when air-dried could be kept, without fear of decomposition, until an opportunity for the chemical investigation presented itself. The grinding of a wet fibrous material such as macrozamia is a difficult matter, but it was carried out with satisfaction in the 5 horse-power Van Gelder grinder machine which had been installed for the purpose.

Four different parcels of bulbs were received from the Forestry Commissioners—two from Bateman's Bay (South Coast) and one from Wyong, a district about 50 miles north of Sydney, and one from Murwillumbah, Tweed River. The six bulbs from Wyong were small, and had evidently been dug out of sandy soil; on account of their small size these bulbs received were taken for investigation in three lots of two bulbs each. The bulbs from Murwillumbah were more cylindrical in shape, and grew chiefly above ground. The bulbs from Bateman's Bay were similar to those from Wyong in shape, but were larger and grew chiefly above ground. They were, however, considerably older than those from Wyong. All the specimens were identified by Mr. J. H. Maiden, F.R.S., Director of the Botanic Gardens, Sydney, as *Macrozamia spiralis.* The approximate age of the bulbs was computed by counting the annual growths.

The largest of the bulbs weighed 388 lbs., and its age was computed to be 120 years; the smallest weighed only 18 lbs., its age being 65 years. The average yearly increase in weight during the total period of growth, for the inner core, ranged from 0.1 to 1.6 lbs., and for the outer core, from 0.1 to 4.3 lbs.

II.—Methods of Investigation.

In order to obtain alcohol from macrozamia, the contained starch must first be converted to sugar and then fermented. In a preliminary investigation, inversion of the starch was effected by both diastase and by acid hydrolysis, and the yields of alcohol compared. The results were very similar, those from the acid hydrolysis being generally slightly greater. For the main investigation, acid hydrolysis was chosen, chiefly because better control is obtained. The chemical analysis was carried out by Miss Hindmarsh, B.Sc., Demonstrator in Physiology, Sydney University, and Mr. A. Kellick, Demonstrator in Chemistry, Sydney University.

* The Forestry Commission, N.S.W., advises that the cost of obtaining and delivering on wharf at Bateman's Bay of the cores only (outer covering removed) would be about 20s. per ton.—Ed. S. and I.

The percentage of alcohol in solution, the quantities of alcohol obtained from the whole bulb, and from the inner and outer parts of the core, respectively, are shown in the following table:—

TABLE I.—MACROZAMIA INVESTIGATIONS.

Yields of Alcohol from Bulbs.

District.	Reference Number.	Per Cent. Alcohol in Solution.		Gallons Alcohol from each Portion of Bulb.		Gallons Alcohol from Whole Bulb.
		Inner.	Outer.	Inner.	Outer.	
Bateman's Bay	1	0·80	1·34	0·131	0·772	0·903
" "	2	1·55	1·79	0·132	0·549	0·681
" "	3	1·30	1·01	0·222	0·439	0·715
" "	4	1·39	1·17	0·471	0·775	1·246
" "	5	2·00	1·06	0·457	0·720	1·177
" "	6	2·09	0·56	1·010	0·273	1·283
" "	7	2·16	0·79	1·781	0·631	2·412
Wyong	1	0·34	0·94	0·009	0·134	0·143
"	2	1·16	1·34	0·156	0·605	0·761
"	3	1·05	0·73	0·041	0·131	0·172
Murwillumbah	1	0·13	0·10	0·003	0·003	0·006
"	2	0·47	0·20	0·022	0·005	0·027
"	3	0·92	0·04	0·098	0·002	0·100

The gallons of alcohol yielded per ton (2,240 lbs.) by the inner and outer portion of each undried bulb, and also the gallons per ton yielded by each complete undried bulb, were thus obtained, and are given in Table II.

TABLE II.—MACROZAMIA INVESTIGATIONS.

Yields of Alcohol expressed in Gallons per Ton.

District.	Reference Number.	Gallons Pure Alcohol per Ton Inner Core.	Gallons Pure Alcohol per Ton Outer Core.	Gallons Pure Alcohol per Ton Whole Bulb.
Bateman's Bay	1	8·38	14·50	13·13
" "	2	18·46	21·77	21·04
" "	3	12·44	9·87	10·54
" "	4	14·08	11·65	12·46
" "	5	19·70	10·68	12·99
" "	6	19·32	4·86	11·83
" "	7	20·35	7·64	13·92
Wyong	1	2·50	7·68	6·80
"	2	10·62	14·42	13·43
"	3	7·10	5·63	5·93
Murwillumbah	1	1·41	0·69	0·70
"	2	4·12	1·42	3·05
"	3	7·56	0·29	4·97

The residual moisture in the air-dried samples (obtained by heating weighed quantities in a steam oven) was found to vary very little, and the average figure for six different samples was found to be 11.3 per cent.

III.—Conclusions.

The first deduction from the figures for the yield of alcohol is that, as a source of industrial alcohol, the bulbs from the Murwillumbah district were useless, while those from Wyong gave considerably less alcohol than those from Bateman's Bay. The interest in this result lies in the fact that the principal supplies of macrozamia in New South Wales are found in the South Coast districts.

The next point of importance brought out by the investigation is that, contrary to expectation, the outer cores of the bulb yield considerable quantities of alcohol, and in several instances, as shown in Table II., larger yields of alcohol per ton were obtained from the outer core than from the inner core of the same bulb.

The Bateman's Bay bulbs were the only ones of which samples were obtained at different periods of the year, and closer study of the results from these bulbs indicates fairly definitely that a transference of starchy material from the outer to the inner core takes place at certain seasons, and that consequently at these periods the inner core is richer and the outer core poorer in starch than at other seasons. If the figures for the first five bulbs collected in October, 1918, are taken, it is found that 218 lbs. of inner core give 1.414 gallons alcohol, while 587.5 lbs. of outer core gave 3.309 gallons, corresponding to yields per ton of 14.52 gallons from the inner core and 12.63 from the outer core. For the whole bulbs, 805.5 lbs. gave 4.723 gallons, or 13.13 gallons to the ton. The ratio of weight of outer core to inner at this period of the year was 2.7 : 1.

For the two bulbs collected in January, 1919, the figures were:—313 lbs. inner core gave 2.791 gallons; 318 lbs. outer core, 0.9047 gallons; corresponding to yields of 19.97 gallons and 6.37 gallons per ton for the inner and outer cores, and 13.12 gallons for the whole bulb. The weights of outer and inner core were in the ratio of nearly 1 : 1. The leaf bases of the specimens collected in October were very rich in starch, and the analysis indicates that in the period between October and January a large portion of the starch from the outer core was transferred to the inner. The outer core decreased in weight relatively to the inner, while the percentage of starch in the weight of the whole bulb remained very constant. Further investigation on samples of bulbs collected throughout the year is necessary to confirm these results, and to determine at what period in the year the starch-content of the inner core reaches its maximum.

In regard to the starch-content of the plant, Table III. gives the percentages of starch obtained by calculation from the yield of alcohol on fermentation. It was hoped to determine the starch by other methods, but, although some preliminary tests have been carried out by Miss Hindmarsh on this portion of the work, no time has been available to provide separate figures. In fermenting starch solutions from

raw products, a theoretical yield of alcohol is not to be expected, and consequently starch percentages calculated from alcohol results tend to be low. On the other hand, not all of the fermentable sugar present after hydrolysis is necessarily due to starch, and this tends to make the starch percentages higher than they really are. In the present investigation it is considered, in view of certain tests made, that nearly all of the fermentable sugar was derived from the inversion of starch, and consequently the figures given for starch in Table III. may be low, but only to a slight degree.

TABLE III.—MACROZAMIA INVESTIGATIONS.

Percentage of Starch calculated from Yield of Alcohol.

District.	Reference Number.	Per Cent. Starch Inner Core.	Per Cent. Starch Outer Core.	Per Cent. Starch Whole Bulb.
Bateman's Bay	1	5·23	9·05	8·19
,, ,, ...	2	11·52	13·58	13·12
,, ,, ...	3	7·76	6·16	6·58
,, ,, ...	4	8·78	7·27	7·74
,, ,, ...	5	12·30	6·66	8·11
,, ,, ...	6	12·05	3·03	7·38
,, ,, ...	7	12·70	4·77	8·68
Wyong	1	1·56	4·79	4·24
,, ...	2	6·63	9·00	8·38
,, ...	3	4·43	3·51	3·70
Murwillumbah	1	0·88	0·43	0·44
,, ...	2	2·57	0·89	1·90
,, ...	3	4·72	0·18	3·10

The results from Bateman's Bay gave the best and most consistent results, and on summing these up it is found that 531 lbs. inner core gave 4.025 gallons alcohol, equivalent to 17.73 gallons (18.67 of 95 per cent.) alcohol per ton; 905.5 lbs. outer core gave 4.214 gallons, equivalent to 10.43 (10.98 of 95 per cent.) gallons per ton; while 1.436.5 lbs. of the whole bulbs gave 8.435 gallons, equivalent to 13.13 (13.82 of 95 per cent.) gallons per ton. The percentages of starch corresponding to these figures are—inner core, 11.06; outer core, 6.51; whole bulb, 8.19 per cent.

Bulletin No. 6, on the subject of Power Alcohol, issued by the Institute of Science and Industry, contains a table, page 19, giving the percentages of alcohol obtainable from various substances. The yield from macrozamia is set down as 18 gallons per ton. This figure refers to the alcohol obtainable from the inner core, and is thus in agreement with the average figure from the inner cores of the Bateman's Bay series.

The age of the bulbs and the rapidity of growth has a very important bearing on the question of utilizing macrozamia as a source of industrial alcohol. Professor Lawson stated at the outset that the growth of these plants is very slow indeed. This was confirmed by an examination of

the bulbs used for the purposes of the present investigations. The average yearly increase in weight of the Murwillumbah bulbs is much less than that of the bulbs from the two other districts. The growth of the plants being so slow, it is clear that the economic use of macrozamia depends upon the quantity of material already available.

From the point of view of alcohol production, the high fibre-content of the bulb is a disadvantage, since the solutions for fermentation must be considerably diluted with water in order to make it possible to work with them. This applies more particularly to the outer cores, the fibre-content of which is generally very high. The high fibre-content of the outer cores is shown in Table IV., which gives complete figures for some of the Bateman's Bay series.

TABLE IV.—MACROZAMIA INVESTIGATIONS.

Particulars of Bateman's Bay Bulbs.

Reference Number.	Total Water.	Fibre.	Starch.	Soluble Extract in addition to Starch.
1. Outer	53·1	16·3	9·1	21·5
4. Outer	57·2	17·8	7·3	17·7
6. { Inner	62·1	6·2	12·1	19·6
6. { Outer	62·3	20·7	3·0	14·0
7. { Inner	61·3	7·8	12·7	18·2
7. { Outer	59·1	20·9	4·8	15·2

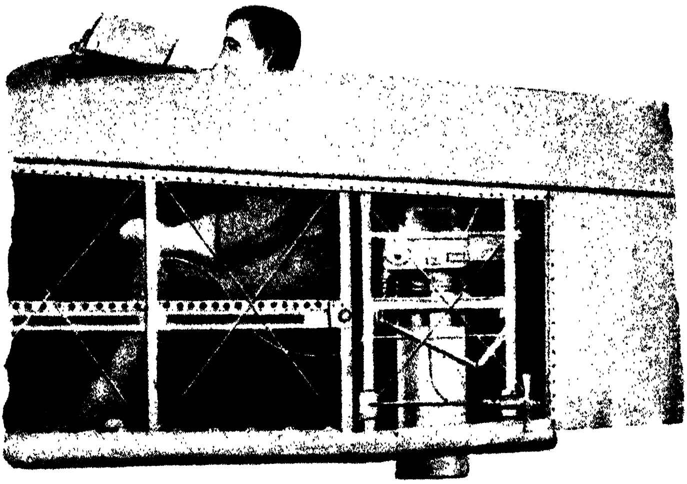
It would probably be possible to hydrolyze the fibre and convert it into fermentable sugar. If this could be done cheaply, not only would the yield of alcohol be increased, but the trouble caused by the presence of so much fibre would be removed. In this connexion it should be noted that wood has been used commercially as a source of alcohol, and that hopes are entertained of hydrolyzing peat and making use of it. An experiment conducted with more concentrated acid on the fibre of macrozamia showed that it appears to hydrolyze readily, and a good yield of bodies, which reduced Fehling's solution, was obtained, but no attempt was made to determine whether alcohol could be produced from them. Until some use can be found for the fibre, or it can be proved advantageous to completely hydrolyze it, attention must be confined to the inner core as a source of alcohol. In this connexion there is the possibility that the residue left after fermentation may prove of value as a cattle fodder. High fibre-content is a hindrance to the extraction of starch, so that it appears unlikely that the outer core has any value at the present time. This makes it all the more necessary to determine at what period of the year starch-content of the inner core reaches its maximum.

In conclusion, acknowledgment is made to Mr. Gilbert Wright, Lecturer in Agricultural Chemistry, University, without whose interest and assistance the investigation could not have been carried out.

Aerial Photography and Surveying from the Aeroplane.

By EWEN MACKINNON, B.A., B.Sc.

The aeroplane owes its present prominence to the requirements of the great war, and but for that war its development would have been probably decades in reaching its present standard. It had few practical uses before 1914. The whole situation has been changed, and now many different planes are made, each for its own special purpose. In 1918 England was making twenty-three different varieties for naval and military work.



THE "LB" TYPE AS MOUNTED ON THE AEROPLANE.

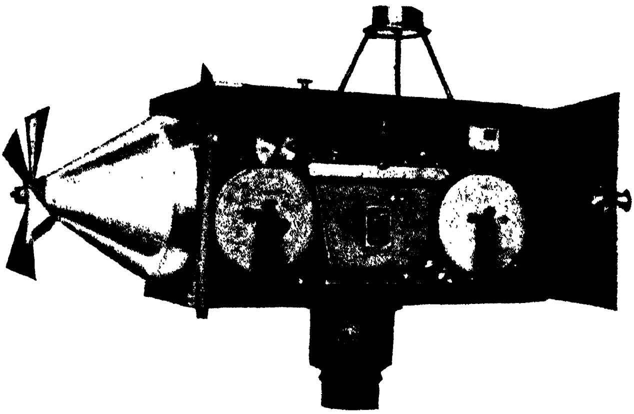
Similarly with the art of photography, wonderful advances have been made, especially in aerial photography, which was an almost unknown field. The accounts of the evolution of aerial cameras and lenses during the war form a most interesting story, and reveal the fact that the optical and photographic firms of England, with official scientific co-operation, produced new varieties of glass, new lens designs, and new types of camera which surpassed all others in existence. Lenses varying in focus from 4 inches to 36 inches were wholly made in England, and excel in every respect (in correction for spherical aberration and for astigmatism, and in freedom from coma) any lens yet made by Zeiss or Goerz.

In aerial photography one of the first difficulties to be overcome was the flat, hazy, and vague appearance of pictures taken from about a mile and a half up in places like Flanders. What was required was to overcome the lack of contrast or, if possible, to emphasize contrasts, *e.g.*, over dark ploughed fields or great brown stretches of mud across

which ran paths mud-coloured like their surroundings. Such success was achieved that in the photos. the paths stand out as white lines. In the manufacture of short-focus, wide-angle lenses, for the purpose of securing photographs over large areas in order to study massed formation of troops, notable results have been achieved. The 4-in. Primoplane lens, from an altitude of about $3\frac{1}{2}$ miles, has produced such sharp, clear images over the whole plate that in the enlargements barbed-wire entanglements could be readily detected.

The Evolution of the Camera.

Such wide-angle lenses will be of considerable value for aerial survey work over large areas, as a photograph taken on a 5 x 4 plate from a height of about 2 miles will cover an area of 5 or 6 square miles, and some of the automatic cameras in use can make 250 exposures of 5 x 4 in. pictures on a roll of film at one loading. In this way several hundreds of miles of country can be covered and photographed. Other cameras take large-size pictures (10 x 8 approximately) direct, and can make forty exposures on a flight.



THE TYPE "F" FILM CAMERA.

The camera has gone through a rapid evolution. Many improvements were patented by Major Laws in 1917 in his B and F types of automatic cameras. Short-focus wide-angle lenses were designed for the low-altitude fliers, and long-focus lenses up to 30 inches for those compelled to fly high out of reach of the anti-aircraft guns. A series of cones were provided by which lenses of any focal length could be used as desired on the one camera. The shutter, being most liable to damage, was made of the self-capping roller-blind type, held in position by spring clips, and removable without interfering with the other mechanism.

For general topographical survey work, a camera first used by the Flying Corps in 1916, and known as camera F, was exceptionally useful. A continuous series of 5-in. x 4-in. pictures can be taken on a roll of film sufficient for 120 exposures. When the pilot wishes to take photos. he pulls a small lever. This releases the mechanism, which is operated automatically by a small air propeller, whose rate of revolution is

regulated by the speed at which the aeroplane is travelling. The photos. are taken at intervals, which correspond with a definite horizontal distance travelled by the plane. Thus every few miles a photograph is taken, and the quicker he flies the quicker the air propeller works the mechanism. The rate can also be altered by moving a small lever on a slotted scale, thus allowing for lenses of different focal lengths covering different lengths of country, and for variations due to changes in height.

Simultaneously with the exposure of each section of film a tiny record is made on each (by means of a supplementary lens) of the reading of the height of the machine and of its compass bearings, so each negative is provided with a record of the direction of flight over the territory that is being photographed. There are times, however, when the compass behaves in a very erratic fashion during flight, and compass direction is not yet sufficiently reliable. An interesting story is told of the work of this camera during its trials at Farnborough. An officer was sent to make a strip photograph of a certain stretch of the Thames, to show that a series of exposures could be made without gaps and without undue overlaps. When the film was developed, a most mysterious blurring of three or four pictures was found, as well as one or two negatives entirely blank. After much investigation and theorizing as to the cause, it was eventually found out by the admission of the pilot that he was the cause, as he had looped the loop, just to see how it looked on paper.

The method of fixing the camera in the plane may vary. Many distortions are introduced into aerographs by the inclination of the axis of the lens, by the changing contour of the land, and slight alterations in height of the aeroplane. Such errors must be corrected before using the pictures for map making. Experiments have been made with gimbal rings and dash pots to give the camera the movements of a damped pendulum, so as to secure it always in a vertical position, and free as possible from vibration. The results have not been sufficiently satisfactory. Mertie and others in the United States of America have used a camera mounted as a pendulum, controlled by a gyroscope, and results have been encouraging. Deviations up to 2° from the vertical were given, and this is too great an error to permit of uniformly good register between adjoining negatives. Better results are hoped for, especially from a more stable type of aeroplane than the one they used (J.N-4-type Curtiss).

Types of Maps—and Control Points.

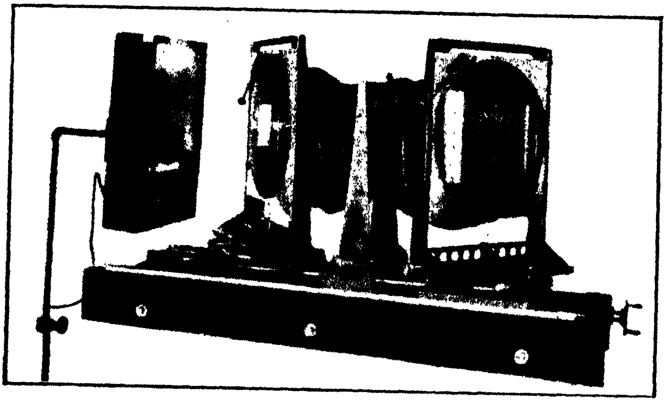
Maps are made to many different scales, and there are many varieties, such as plan maps showing natural and cultural features, and relief maps showing, by contour lines or other means, the regional relief. The general topographical map includes most of these features, but vary in scale—the United States of America being commonly 1 in 250,000 to 1 in 62,500, while the British scale is 1 inch = 1 mile.

Series of aerographs fitted together do not constitute a true map. There may be errors due to distortion, to different scale photos., and lack of geodetic control. Even when all the photos. have been brought to the same scale, and distortion corrected, an accurate map requires

control points. These are the triangulation stations that have been accurately determined and marked. If the controls in any one area are not properly co-ordinated with those of another area near it, the result would be that when different topographical surveys and maps are joined there would be overlaps, gaps, and off-sets, which would cause no end of trouble and confusion to the map maker.

CORRECTING DISTORTED PICTURES—AUTOMATIC CAMERAS.

As the methods that have been tried for maintaining the lens vertical have not given sufficiently accurate results for some purposes, other means have been investigated. One has been to refer each picture, when taken, to some stable reference point, so that the tilt of the negative and the direction of the tilt may be ascertained. Such data will be sufficient with the aid of certain apparatus and methods to rectify the negative to the plane of the horizon. The gyroscope has also given great promise in this direction.



TRANSFORMING CAMERA, WITH REVOLVING DISKS CARRYING NEGATIVE AND PLATEHOLDER.

So far the most reliable results have been obtained by taking the photographs with a fixed camera, and making the necessary corrections. The amount and direction of the tilt are known, and also the height of the aeroplane. How can these negatives showing such distortion be corrected? Notable results have been obtained by M. L. P. Clerc, who has carried out extensive research work for the French Aviation Service during the greater part of the war. Clerc investigated, with great thoroughness, the mathematical conditions involved in transforming the photograph taken by an inclined aerial camera into one corresponding with that obtained from the same point of view, but with the lens vertical. As a result of his investigations a camera was designed with which the distorted photograph is automatically corrected, or, in other words, by which an orthographic projection is obtained from a negative taken at any angle. A similar result has been achieved in the United States of America, and a transforming camera has been designed and constructed by F. H. Moffit, of the Geological Survey, by means of which the negatives taken in any one plane can be transformed into any other plane.

Relief and Contour Lines.

In regions of very low relief the corrected aerophoto. approximates very closely to an accurate plan map. But if the pictures are taken in a region of moderate relief the result is not a true plan map, because of distortion caused by the relief itself. This has not been corrected in the transformation camera. Clerc, however, has devised methods for the estimation of the height of objects by the measurement of their cast shadows in aerial photos., so that contours can be readily inserted in the chart. Over wooded areas it is practically impossible to show contours. This is a disadvantage in forest survey work. Yet the limits of woodlands and types of woodland can be determined from the photographs. Promising results have been obtained by the use of stereophotography, particularly by the use of an instrument known as the stereo-comparator.

It may be seen, then, that photographic surveying from aeroplanes is practicable and accurate to a very large degree. Although there are some large problems to be solved, much has been accomplished in a few short years, and very much valuable work could now be done with such speed and accuracy that was not dreamt of before the war.

Rapid and Enormous Development of Aerophotography.

When we consider that the whole of this development has practically taken place in three years, and the enormous extent to which aerial photography was applied at the time of the armistice, it is quite reasonable to hope that the remaining difficulties in the practical application to topographical surveying will be soon overcome, and that the extensive facilities for war work will be utilized in the peaceful mapping of the world. The first aerophotos. used by the British Forces were supplied by the French in February, 1915. They were of an area about to be attacked by the British. When their value was fully realized, it is to their credit that their previous lack of encouragement was changed into a policy of rapid development. Within a week the first special camera for aerial work was designed, made, and delivered in France, and the photographic section commenced with a force of two lieutenants and a sergeant.

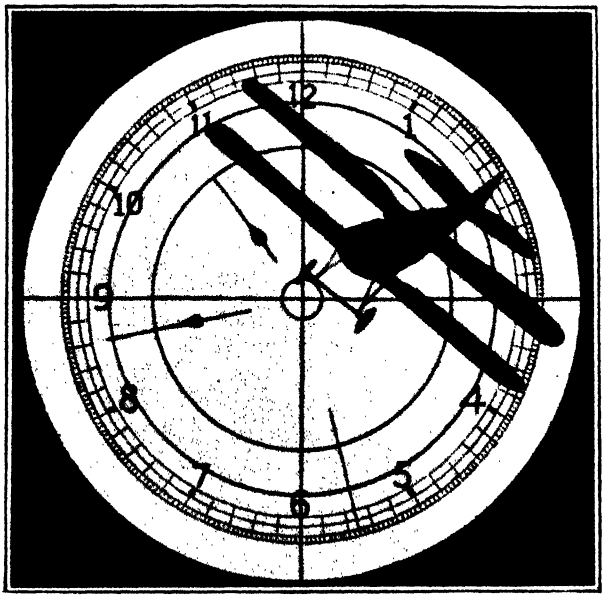
During the last year of the war 6,500,000 prints were made for the Royal Air Force. In one case, just before an attack in August, 1918, one section alone produced 23,000 full plate photographs in 36 hours. Owing to the accuracy of aerophotography, the British photographed practically every acre of ground from Arras to the sea, and up to 50 miles behind the German line. It was by the aid of photography that accurate shooting from the aeroplane was taught. The shooter operated a camera just like firing a Lewis machine gun. This Hythe Mark III. gun camera recorded his hits on a travelling film, and also recorded the exact time. If a hit was scored, a picture of the aeroplane was recorded in a clock dial form.

Training of Men and Interpretation of Aerophotos.

The training in the School of Aerial Photography, which had grown to quite an institution with the Forces, is very extensive. It includes—besides a thorough knowledge of the various types of cameras and their

use—the principles of colour photography, the production of stereoscopic and mosaic photographs, enlarging and reducing, the rapid production (especially drying and finishing) of prints, map reading and plotting, and a host of other subjects indispensable to the practice of aerial photography. Instead of the quick uncertain impression formed by the observer, the camera now produces a permanent, reliable record that can be studied at leisure.

The amount of useful photographic survey work that could be carried out, especially in Australia, must be enormous. It is recognised that the making of topographical maps is a specialized science, and that photo-mapping is only one phase of the general science of cartography, which requires sound tra'ning and practice. Map making has been considered



A "HIT" RECORDED ON THE FILM OF A GUN CAMERA.

The crossed lines serve to indicate the accuracy of the aim. Time is shown by the hands down to fifths of a second.

an engineer's job, and good pictures will not alone produce a perfect map. On the other hand, when certain problems already mentioned have been solved, the method of aerial mapping will displace an enormous amount of the present slow, less accurate, and more costly methods of a large amount of map making of to-day.

Work in Australia.

From inquiries made at the Forestry and Lands Departments of the various States, and the Defence Department, there is a general expression of sympathy with aerial photographic survey work in Australia, but all plead a lack of funds. Most of the Departments agree that there is a large amount of work awaiting to be done that could be accurately and quickly done by aerophotography. The greater part of the cost is the initial outlay.

For bringing all maps up to date, aerial photography is the quickest and most detailed. There should not be any difficulty in delimiting pastoral and Crown lands, reserves, and woodlands; in providing information to the valuator on areas of scrub, stony, sandy, or swampy land, amounts of clearings, areas under cultivation, alterations in settled areas, drainage improvements, fencing, &c.; in mapping flat stretches of country and sandridge country, large extents of which exist in Australia.

Although the method may be unsuitable for forest valuation, yet accurate information as to the extent of our forest areas, the nature of the surrounding country, and the type of woodland must be of great value. Round the coastal areas much useful work could be carried out during low tides.

Preliminary survey work could be made over large areas of unsurveyed country, and preliminary sites determined for trial routes for detailed survey for railways, and reservoirs, and water conservation areas.

A Plea for Co-operative Work.

As these matters are well known to the military authorities and Lands Departments, it is hoped that some scheme of co-operation will be worked out at once to employ our well-trained aerial and aero-photographic forces with those of the State Survey Departments in work such as that briefly mentioned above, but which at the present time is of such vital importance to our policy of Advance Australia.

"At all periods of the world's history certain problems have impressed themselves on men's minds as being of paramount importance. History affords many examples of this. From the doctrine of "the divine right of kings" to the question of "women's suffrage" is a long step, but not a longer one than from the once all-absorbing theme which exercised the minds of men of science as regards the true nature of phlogiston to the present contest regarding the structure of the cobaltamines. Science has, however, this advantage over politics—that experiments devised to decide knotty questions are more easily carried out; and, further, that it is in the interests of no one to conceal the truth."

—SIR WILLIAM RAMSAY.

Scientific Research in the United Kingdom.

By SIR FRANK HEATH, K.C.B.*

No. II. (*continued from page 440*).

THE second branch of the work of the Department of Scientific and Industrial Research deals with the encouragement of research in the industries. The Advisory Council recognised that many of our industries were making less use of science than was desirable, or indeed necessary, if they were to survive. But they realized that there were many causes for this. They refused to indorse the easy cry that manufacturers were too ignorant or too indolent to make use of scientific men. This may be one factor in some cases, but it is by no means the whole story. The Council attempted to analyze the position in their first annual report, and I need not repeat the analysis here. It will suffice to say that the relatively small size of the majority of British firms, the shortage of well-trained researchers, and even of routine workers in science, and the lack of mutual understanding between the Universities and the industries, were some of the difficulties in the road. The Council reached the conclusion that any safe advance must be made by the industries themselves, that the most hopeful means was co-operative actions by the firms in each industry, and the best the Government could do was to encourage co-operation, while leaving the immediate responsibility to those who presumably knew most about the conditions of the industry, *i.e.*, to the manufacturers themselves. Thus the scheme for co-operation research associations came into being. These associations are limited liability companies working without profit, and with a nominal guarantee from their members in place of shares. The members of each association make an annual subscription usually, proportionate to the size of their business, towards the income of the association; and when the memorandum and articles of the association have been approved by the Department, and a licence has been issued by the Board of Trade, the Board of Inland Revenue recognises the subscriptions of the members as "business costs," *i.e.*, as free from income tax and excess profits duties. If, in the opinion of the Department, further help is needed, it will make an annual grant-in-aid to the association for a period of five years. This grant is, in the first instance, usually £1 for £1, but the average over the whole five years will in most cases be less than this. The intention is to give the new associations an impetus over a period sufficiently long to enable them to prove the value of research. After that, it is anticipated that they will need no encouragement to continue the work.

CO-OPERATION WITH INDUSTRIES.

The Department acts as a clearing-house of information for the associations, and gives all the assistance and advice in its power, whether the association is in receipt of a grant or not. The association has full control of its own income, whether from the Government or from its members, and all the results of research are the sole property of the association held in trust for its members. The Department asks to be kept informed, acts as the go-between when an association seeks to sell its results to another industry or association, and reserves the power to prohibit the communication of results to a foreign body or person. But this is the limit of Government interference. The Advisory Council laid stress upon the representation of science, as well as capital and management, on the Board of Directors, and they think it desirable that there should be some representation, if possible, of skilled labour. They also lay great stress upon the appointment in each case of a responsible technical officer as director of research, in order to insure the unity of direction, which is as necessary in research as in the battlefield. Two other important points of detail should be mentioned. The scheme of the Advisory Council contemplates that the associations should be limited in each case to those firms in an industry, or in groups of closely related industries, whose interests are sufficiently homogeneous to induce them to pool their resources for the purpose of research. It will not

* Secretary, Department of Scientific and Industrial Research, London.

usually be feasible for both producers and users to combine in a single association unless, as in the case of cotton, the producers and users are so intimately related that the processes of each immediately affect the whole business of the other. The various non-ferrous metal trades can combine without difficulty. The different branches of the internal-combustion engine trade cannot. The problems of the aeroplane engine and the heavy Diesel motor are at present too remote from each other.

The second point is that the scheme contemplates the establishment of one association of each kind for the whole United Kingdom—not a series of local associations. Experience has shown that a number of local associations in the same industry would raise questions which would inevitably lead to Government interference, and that the number of competent research workers, and especially men fitted to be directors, is far too small to allow of this procedure. A single national association avoids this danger, and has the important advantage of commanding larger resources as well as wider experience. On the other hand, where an industry is widely distributed over the three kingdoms, provision is made for local branches and committees with large scientific autonomy, so as to allow the research undertaken to correspond with the variety of problems arising from local differences in material, or processes, or types of product.

THE ORGANIZATION OF NATIONAL RESEARCH.

We may now turn to the third section of the field which I have spoken of as the Organization of National Research. You will have noticed that all the work already described is national in a sense, but it is work which the Advisory Council realized the Department had better delegate to authorities, not itself. There remains a growing body of work which, for one reason or another, the Government must do itself, and this is what is meant by the phrase "National Research." The work in question may be divided into three sub-heads. Here, again, it will be seen that, leaving aside the function of intelligence, which is a matter of orderly collection, collation, and distribution by competent officers acting in general conformity with the directions of the Advisory Council itself, the policy is one of delegation to persons specially qualified by their knowledge and experience to do the work in hand, with great freedom to initiate and carry out a scheme of work which they themselves have devised.

I.—A Clearing-house of Information.

I have always referred incidentally to the function of the Department as a clearing-house of information for the Industrial Research Associations. It similarly acts as a clearing-house for all the research organizations and workers with which it is officially connected. But it confines itself to this. The workers of the research associations, the research boards, and research committees working officially under the Department, will often be doing confidential work of great interest and importance to each other, and if there is not some central clearing-house, the rate of advance will be much slower than it need be. This service the Department is undertaking, and it is likely, even when thus narrowly defined, to be a fairly big business. Moreover, the Department is slowly constructing a confidential register of research workers, and their work for the benefit of the different organizations related to it; and now that the great war services are being curtailed, an inventory of scientific apparatus and machinery of which the Government is anxious to dispose. It is also slowly forming a technical library, and hopes that this library, as well as a common room, may be used by officers and directors of the research associations for meeting each other, and discussing with officers of the Department matters of common interest.

II.—Investigations Carried out for other Departments of State.

The next sub-head of National Research deals with investigations carried out for other Departments of State. It had been recognised from the beginning that if the Department were to initiate researches of its own on the advice of the Advisory Council, without knowing the bearing they might have on the work or intentions of other Departments of State, confusion, and worse than confusion, might result. Accordingly, the Minister invited each Department of the Government to appoint one or more assessors to the Advisory Council. The assessors have the right to attend the meetings of the Council,

and receive the agenda-papers and minutes of the Council. They also furnish the natural channel of informal communication between the Department of Research and the Departments they represent. This device has had the happiest results. Thus the Home office invited the Department to investigate the question of mine-rescue apparatus. The first report of the Committee established by the Advisory Council has proved on publication to be so valuable in directions hitherto unexpected, that the Commander-in-Chief in France asked that the Committee might be placed in touch with General Head-Quarters. The Local Government Board invited the Department to undertake a series of researches into building materials in connexion with the housing policy of the Government, and this led to similar requests from the Commissioners of Woods and Forests as regards home-grown timber, from the War Office, and from the Board of Agriculture. So that from small beginnings a large body of researches into problems of building has been undertaken. These are but two examples out of many cases in which other Government Departments have welcomed the services which a Department of Research can render.

III.—Research Boards.

When a large group of researches has to be undertaken in the national interest, and an elaborate organization for research has to be set up, the Advisory Council has recommended the Minister to give the Research Committee a more independent status, and to place it in closer relation to himself. This is the third type of organ for national research, and is called a Research Board. The work done by Boards is not only wide in scope and complex in organization, but it is always work which, for one or more reasons, is not susceptible of organization by an autonomous body like a research association. It is also work which must, because of this, be paid for altogether, or almost altogether, by the taxpayer. The first Board of this kind to be established was the Fuel Research Board. Fuel and economy in its use affect the poorest worker in the land as intimately as the largest consumer. Fuel is the basis of all our industries, and of our supremacy at sea. No association of manufacturers could be expected to attack so wide a range of problems in all its parts. The cheapest and fairest way of distributing the burden was to place it on the shoulders of the taxpayer. In a word, this was a typical piece of national research. The same arguments apply to the preservation of food as to the conservation of coal, and at a later date, Lord Curzon established the Food Investigation Board to deal with this vastly important group of problems.

The Advisory Council has been considering the question of fuel at the earliest of its deliberations, and the report of Lord Haldane's Coal Conservation Committee made definite recommendations which led directly to the establishment of the Board. In the case of food, the impetus came first from the Ministry of Food and the Board of Agriculture and Fisheries, both of which Departments were deeply concerned in the feeding of the people. Similarly, it was the Secretary of State for Home Affairs and the Medical Research Committee which, severally and within a single week, invited the Advisory Council to take up the question of industrial fatigue. This led to the establishment of the Industrial Fatigue Research Board which, apart from the importance of its special field of work, is interesting, because it was appointed jointly by the Research Department and the Medical Research Committee.

The responsibility and initiative intrusted to a Research Board are very great. When the Minister has appointed a Research Board on the recommendation of the Advisory Council, the Board is invited to prepare a scheme of work and a Budget of expenditure. These are submitted to the Minister, together with any remarks upon them the Advisory Council may wish to make. The Council does not amend the scheme or estimates of a Board, for Research Boards are responsible directly to the Minister, and their chairmen have immediate access to him. The less important Research Committees are appointed by the Council itself, and are subject to its control, both in their schemes of work and their proposed expenditure. The recommendations which go to the Minister are recommendations of the Council, not of the Committees. But both Research Boards and Committees, when once their proposals are approved, have full power to expend the appropriations made to them, subject only to the rules imposed upon all public expenditure by Parliament.

SCIENCE AND INDUSTRY.

The Principle of Delegation.

The Research Boards and Committees consist of men of science, men of business, and technical officers of the Government Departments concerned. They prepare schemes of work, select the researcher, and determine the amount of his remuneration; but they do not, as a rule, conduct research themselves. They are executive bodies. The Advisory Council is not executive, but deals with general policy. Here, again, it will be seen that the procedure has been to delegate authority, even in the case of research carried out by the Government for national purposes to bodies of experts. It was well said some years ago that the main problem which Government Departments would have to solve in the present century was how to use the expert. The Research Department is an experiment in this direction. The attempt to differentiate the work of the Department according to function, and give each class of work to the appropriate type of worker, has not only secured the strenuous assistance of the man of science and the man of business, each contributing from the fullness of his own knowledge, but it has greatly strengthened the position of the civil servant, whose business is administration. It has strengthened it because it has limited his responsibility to the matters which belong to his kingdom. The administrative head of the Department has no power to advise his Minister upon the scientific policy to be pursued, and it would be improper for him to do so, were he the most distinguished man of science in the country. Since he is only an administrator, he is under no such temptation. If the scientific initiative emanates from the Minister himself or from another Department, it stands referred to the Advisory Council. All other initiative derives from the Council itself.

The sum up. The activities of the Department are exercised in three main directions. First, it seeks to encourage the worker in pure research by looking for him in the places where he is most likely to be found, through the eyes of individual men and women who are themselves engaged in research and teaching others how to begin. When the man or woman has been found who needs assistance, they receive it in liberal measure, with no restrictions beyond the necessity of showing that they are continuing their work. Secondly, the Department is helping the firms in different industries to co-operate, with a view to raising the funds necessary for employing first-rate men of science in the solution of the problems with which they are faced, and in the scientific development of the industry in question. In this connexion, the Department is building up a clearing-house of information for the benefit of all concerned. Finally, the Department is offering its assistance, on the one hand, to other Government Departments who desire to have research undertaken on a scale, and for purposes which they cannot themselves easily compass. On the other hand, it is organizing research into problems of practical utility, which are of such wide importance that they cannot be handled by any one section of the nation. In both regards it proceeds by delegating the responsibility for the conduct of this work not to officials, but to Boards of experts who are intrusted with the preparation of the scheme of work, the employment of the workers, and the control of its execution. The principle throughout is the same—the principle of delegation to those best fitted for the work in hand.

"Englishmen must take heed that in the future, in commercial competition with other nations, we rely less upon exploiting our vast store of natural wealth, and more upon the resources which scientific skill and practical education can place at our disposal."

—H. STANLEY JEVONS

Combating the Blow-fly.

New Treatment Recommended.

The blow-fly pest has long since become a source of serious trouble to the sheep industry in Australia, and annually involves pastoralists in heavy losses. In some years the mortality amongst sheep is much greater than in others, due largely to more favorable weather conditions for the breeding of the flies. The Institute of Science and Industry is co-operating with the Governments of Queensland and of New South Wales in carrying out investigations into methods of minimizing the effects of the pest, and a Committee was appointed in each State to supervise and direct the work. The practical effect of Chalcid wasps, which have been found to destroy the larvæ of the flies, is being thoroughly tested, and wasps are being bred in large numbers. Other lines of investigation are also being followed up, and at Roma (Queensland) highly encouraging results have been obtained from the "jetting" of the sheep with a dip containing 0.2 of arsenious oxide in solution. Upon this phase of the work, Messrs. W. A. Russell, owner of Dalmally Station, Roma, where the experiments are being carried out, and Mr. W. G. Brown, sheep expert of the Queensland Department of Agriculture, and a member of the special committee appointed by the Institute, have submitted the following report:—

> The experiments conducted by the Institute of Science and Industry at Dalmally, Roma, have now been in operation for eighteen months, and sufficiently good results have been obtained to warrant a progress report. These results show that much relief can be obtained by pastoralists by a few comparatively simple and inexpensive operations.
>
> The work done enables three general statements now to be made:—
>
> (1) No specific yet tried completely prevents fly attack.
>
> (2) No specific has given good protection for more than three months.
>
> (3) The use of arsenical preparations has given the most successful results.
>
> Other questions which require much further investigation are:—
>
> (a) The determination of the range of flies from their breeding place. There is some evidence that they do not as a rule travel any great distance. Should this prove to be generally correct, it will be an exceedingly important factor in determining the amount of surrounding clear area necessary for protecting flocks. Much work requires to be done ere the general range of the flies has been determined.

(*b*) The determination of the cause of the very high percentage of deaths from even slight infestation at certain times, while at other times infestation of much of the body surface only causes slight mortality. This seems to involve, among other work, a search for a specific pathogenic organism.

(*c*) The determination of the possibility of killing flies in great numbers by the discovery of more parasites, or other similar means.

The solution of these questions requires an investigation by a skilled biologist, and, until such solutions are established, the problem cannot be considered solved.

The work at Dalmally Station has been largely based on results obtained in investigations by the Department of Agriculture. In addition to the work described below, good results have so far been obtained by the use of traps and poisoned baits, and work has been started in breeding up Chalcid wasps.

For the past eighteen months, fly troubles have been light at Dalmally, but just now (30th August), and for about six weeks back, the indications are that a sufficient fall of rain will bring the pest into full activity again.

Of recent years, the one great stand-by of the pastoralists has been crutching. Experience at Dalmally and elsewhere has proved that a much better and much cheaper method of protection than crutching has been evolved.

Three months after the sheep are shorn, they are subjected to a shower dip containing about 0.2 per cent. of arsenious oxide in solution. Several specifics on the market containing arsenic have been found suitable. This shower dip is repeated again three months later.

In the results obtained so far, the proportion of sheep struck has been far smaller among the dipped sheep than among the undipped sheep.

Just before lambing time, the most dangerous period of the whole year, the use of the Orion Downs jetting method has given two months' certain protection, and may possibly give three months, thus putting the flocks over the very worst period.

The following facts provide a striking example of the greater protection given by jetting than crutching:—

A few weeks ago, thirty thousand (30,000) ewes were inspected which had just finished lambing 80 per centum of lambs. These ewes had been jetted with an arsenical dip prior to lambing. Not a fly-struck sheep was observed in the whole number. Before these ewes were jetted, crutching had been the custom on the station, and it was with much difficulty that the manager obtained consent from the owners to jet instead of crutch the sheep. He has now a better and cheaper method of dealing with lambing ewes.

> A similar flock of sheep in the same district was inspected at about the same time. These had all been carefully crutched prior to lambing, and were well looked after. The numbers were about the same, viz., thirty thousand (30,000). These had to be repeatedly mustered and dressed, over 10 per cent. being attacked by flies.

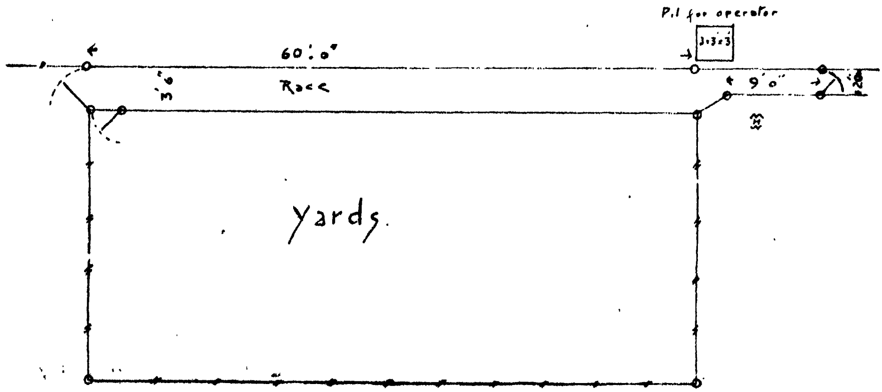
If sheep-owners would only give this process of jetting one trial. instead of crutching, they would be satisfied that they will get a maximum of protection at a minimum of cost.

In the Orion Downs method, the arsenical dip at double the strength as recommended by the makers is jetted into the wool at the breach of the sheep. With the use of a strong power pump the operation is cheap and simple as compared with crutching. The sheep are not knocked about as in crutching, and the work is easier on the men.

The proper method of jetting is to take an ordinary race, such as is used for branding. At one end—the exit—it must be narrowed down to about 20 inches in width, so that a sheep cannot turn in it. This narrow race should be at least 9 feet long. At the end is a gate, which allows the sheep through one at a time. A man is placed at the gate to check too fast a run. About half-way up the narrow race, on the outside, a hole 3 feet by 3 feet and 3 feet deep is dug to allow a man to manipulate the hose, which operates with an "Edgell cut-out." He jets each sheep thoroughly as it passes him. The man at the exit gate prevents the sheep from going past too quickly. The other men pen and keep the sheep up. Six thousand (6,000) sheep per day have been done, and done well.

The method can also be used in the paddocks by using hurdles and gratings which can be carried about on the run on light waggon, with the jetting plant tailed on behind. It is not necessary to try and save the surplus dip, as with careful use very little is wasted.

The attached drawing gives a general idea of the race used. The expense works out at about one halfpenny (½d.) per head.



PLAN OF RACE FOR JETTING SHEEP. CAPACITY, 6,000 SHEEP PER DAY. SIX MEN.

The Viticultural Industry.

Research at Mildura.

By A. V. LYON, B.Ag.Sc.

Important and far-reaching problems are embraced by the scheme of viticultural investigations to be carried out by the Mildura and District Research Committee, in association with the Institute of Science and Industry. They include physical and chemical, as well as pathological and entomological research, and will be directed to the discovery of remedial measures for many of the more serious troubles that afflict the vignerons in many parts of the Commonwealth. All preliminary arrangements have now been concluded, and a commencement has been made with the work. The experiments will be carried out at Mildura on a block of 60 acres, 48 acres of which are irrigable. The agricultural laboratory and library have been erected, and are being stocked, and a number of plots have been planted to serve as a basis for the following investigations:—

1. Fifteen acres have been planted, composed of seven experimental plots.
2. The library and agricultural laboratory have been erected, and both are being stocked.
3. Material (old housing) has been purchased for the purpose of erecting residences for the Agricultural Scientist, and for the workmen.

Our farm assets at present are:—

1. Buildings	£540	18	0
2. Implements and plant ..	87	2	5
3. Improvements to land ..	240	8	6
4. Farm buildings	12	4	2
Total	£880	13	1

These figures give the actual capital expenditure by 30th September, 1919, and represent the value of improvements alone, without taking into account the improved value of 48 acres of land with a water right. The whole of the property as it now stands has been valued by the Committee at considerably over £1,000.

A number of experimental plots have been planted to serve as a basis for the following investigations:—

Plot 1.—Experiment to determine the most payable quantity of phosphatic manures. This field is divided into plots of five rows, sub-plots receiving 0, 2, 4, 6, 8, 10, 12 units of phosphatic manures respectively. This work is being done with currants, sultanas, and gordos, and the results will be judged by the yields of green fruit and dry fruit.

Plot 2.—Experiment to determine the most payable quantity of potash manure. This work is on similar lines to the work detailed above.

Plot 3.—Experiment in green manure. Two plots have been laid down for this work—one of currants, and one of sultanas. The currant plot is on clay soil, and the sultana plots on grey loam (mallee).

Different varieties of leguminous plants will be used (peas, beans, vetches, bersium), and results will be judged by yields and by a chemical analysis to show nitrogen content of the soil at different periods of the year.

Plot 4.—This plot is devoted to methods of planting. Three methods have been used comparatively:—

(*a*) Vine planted with a probe, without digging.

(*b*) Land subsoiled, and vines planted in hole dug with spade.

(*c*) Land ploughed 6 inches, and planted in hole dug with spade.

Comparison of these plots would be made by noting disposition of the roots, the growth of the vines, and by yields.

Plot 5.—Test for best spacing of vines. A plot has been established with variation in distance between the rows, and between the vines in the rows. Plots vary from 12 by 12 to 9 by 6.

Results will be judged by amount of crop, evenness of ripening, and freedom from disease.

Plot 6.—For determination of amount of irrigation water which gives best results. These investigations will be a combination of laboratory and field work, and will aim at showing the rate of disappearance of water from land on which vines are grown, and the amount of soil water necessary to give continuous growth without checks. Results bearing on the best spacing for irrigation furrows, the length of periods between irrigations, and the best time for irrigations should be obtained.

Plots 7 and 8.—These are still in the nursery stage. Phylloxera-resistant cuttings are being struck, and experimental work to determine which of these stocks are best suited to our field grapes will follow.

The methods of establishing vines on resistant stock will be demonstrated. Should Phylloxera come to this district, we should know:—

(*a*) Which of the Phylloxera-resistant stocks are best suited to sultanas, currants, and gordos.

(*b*) What are the most efficient methods of establishing a vineyard locally on resistant stock.

(*c*) Which of the varieties are best suited to different classes of land.

(*d*) Which of the varieties will thrive best in land affected by salt.

Plant Selection.

Cuttings are being struck from known heavy and light bearing strains to endeavour to see to what extent the bearing qualities are due to strain. The continuation of this work will be the establishment by selection of heavy-bearing strains of sultanas, currants, and gordos.

Manurial Experiment on Old Vines.

Mr. O. C. Setford, The Lake, has placed portion of his vineyard at our disposal. A sultana patch has been divided into plots which are receiving 0, 2, 4, 6, 8, 10 cwt. of superphosphates. Similar work is being done on a currant patch. Results from this experiment will commence to come in at the next drying season, and should show the most payable quantity of super. to use.

Activities of the Committee other than the Experimental Farm.

Black Spot.—The amount of work on this disease has been necessarily limited owing to the scarcity of the disease due to dry seasons.

The work on the dormant stage of the disease in the vine has, however, been continued, and the results have been of value to growers. Valuable assistance was given by Mr. Brittlebank, Vegetable Pathologist for Victoria, in connexion with the testing of pitted canes which have been variously treated.

Oidium.—As in the case of black spot, the season has, fortunately, been unfavorable to the disease. Field experiments dealing with the forms of sulphur are being conducted on the properties of McCarthy Brothers, of Merbein. Results, however, cannot be expected until a year favorable to the growth of the disease occurs.

One advantage, however, has been obtained for growers. The sulphur supplies in past years have been insufficiently ground, and were too coarse to be of much value. A standard method (the Chancel test) of testing the fineness of division of the sulphur has been adopted by the Committee, and a great improvement in the quality of the sulphur supplied has been effected.

The efficiency of ground sulphur is entirely dependent on the fineness of division, so all purchasers in the settlement should satisfy themselves on this point before obtaining supplies.

Entomological Observations.

1. *The Dried Fruit Grub (Indian Meal Moth).*—This pest is probably the greatest menace to the dried-fruits industry at present. It is practically impossible to detect the eggs on the dried fruit, but these eggs develop, in most cases, after the fruit has left the district, and seriously affects the quality of the fruit as given to the consumer.

Observational work has been carried out, and will be continued on this matter. The grub in its various stages is still under observation, and experimental work in cleaning the fruit will commence with the next year's pack.

2. *Elephant Beetle.*—This pest still takes a large toll of the district fruit. The life history and the seasonal changes have long been known. Destruction of the tamarisk hedge in the winter time, when they contain the larvæ of the pest in great numbers, is the essential first step. These hedges should be destroyed between the months of April and October, in order to kill the larvæ before the insects emerge.

3. *The Light-brown Apple Moth.*—The grub of this little moth is very destructive, on sultanas particularly. Two broods were reared last year, within the month after the first setting of the berries. One grub in captivity was found to destroy over 40 berries. As the grub is minute in size, and commences its attack when the berries are first formed, close inspection will be necessary to detect it. In nearly every case, its method of attack was to bore a hole through a newly-formed berry from side to side. Spraying with arsenate of lead (2 lbs. in 30 gals. of water) was completely successful in dealing with this pest.

4. *Collection of Insect Pests.*—The suitable cases have been obtained, and placed with Mr. French, at the Science Branch, Department of Agriculture. Mr. French is kindly supplying mounted specimens of the various insect pests affecting fruit trees, vines, and citrus trees. These cases, when completed, will be permanently on exhibition at the Experimental Farm, and should have an economic as well as an educative value.

Fruit Drying.

This problem is rather one for the grower than for the experimentalist, although some useful work still remains to be done.

The practice of "over-cracking" fruit is followed in many cases. Quicker drying is certainly obtained, but over-cracking results in "candying" when packed, and the stickiness of the sample increases possibility of attack from moulds and insects, including the grub on dried fruit, and causes adherence of dust.

A useful range of experiments were conducted last drying season dealing with the following points:—

1. Relationship of the density of the grape juice, and the strength and temperature of the caustic soda solution which cracks very slightly.
2. Relationship of the density of the grape juice, and the loss of weight on drying.
3. Determination of a field method by which strength of dip can be kept approximately constant.
4. Relationship of strength and temperature of dip to the colour of dried product.

Results of this work will be published at a later date, as it would be unwise, and possibly misleading, to give results from one year's drying only.

At the request of the Institute of Science and Industry, the Director of Agriculture (Dr. S. S. Cameron) has kindly consented to the services of several experts of the Victorian Department being placed at the

disposal of the Committee, and the investigations will therefore be strengthened by the assistance of Mr. A. E. V. Richardson, M.A., B.Sc., Superintendent of Agriculture; and Messrs. Scott and Robertson, consulting agricultural chemists; F. de Castella, Viticulturist; and Laidlaw, Brittlebank, and French, of the Pathological and Entomological Branches. It will be seen, therefore, that no efforts will be spared towards arriving at conclusive results. Both from the design of the experimental plots, and the selection of the scientific staffs, provision has been made for obtaining reliable data upon problems affecting the viticultural industry. The growers themselves are providing two-thirds of the money, and have elected a strong committee from amongst their own number to keep in touch with the work. This fact in itself is a good augury. It reveals the determination of a community, whose interests are identical, to further develop a well-founded industry. Both the viticultural and fruit-growing industries are capable of very great expansion in Australia if organization amongst the producers is adopted, and if the difficulties which hinder the most economic production and distribution are scientifically investigated.

"It has been proved without doubt that national life is to an extraordinary degree dependent on the chemist, and that nations neglecting science, and most especially applied chemistry, are treading the path which leads to industrial decay. Germany's success in industry was fostered by a liberal supply of trained chemists and engineers, adequate plant and capital, and co-operation between manufacturers and research workers. Unlike the state of affairs in this country their business men had some knowledge of science, and their scientific men some acquaintance with business."

—CLERK RANKEN.

The Fixation of Atmospheric Nitrogen.

By F. H. CAMPBELL, D.Sc.

(Member of the Special Committee on the Nitrogen Requirements of Australia.)

Like oxygen, the other main constituent of the atmosphere, nitrogen is essential to animal and vegetable organisms. Unlike oxygen in the uncombined condition, nitrogen is available to them in special cases only.

Until the end of last century the requirements of the agriculturist were met without difficulty by the suppliers of nitrogenous animal wastes, of ammonium sulphate, and Chilian sodium nitrate. But, as was pointed out by Crookes and others, the world was living on its capital, and with the exhaustion of the Chilian fields, which now yield 58 per cent. of the fixed nitrogen produced, the demand for nitrogenous fertilizers would far exceed the supply. Since that time several developments have occurred, which have postponed the day when the world will depend solely upon chemically-fixed nitrogen. The proportion of the world's coke made in by-product recovery ovens has much increased, and the discovery of new deposits and improved methods for treating low grade caliche have caused a revision of the estimate of the probable life of the nitrate deposits; it has been increased from 20 to, at least, 100 years. The position, however, is unaltered fundamentally, and the time is approaching when it will become imperative to draw upon the atmosphere for our supplies of nitrogenous fertilizers.

Apart from peace demands, which depend to a great extent on prices, the future of the industry is assured. No great Power, with the possible exception of Great Britain, will now venture to depend solely on overseas raw material of nitric acid and the explosives derived from it. Had it not been for their faith in the capability of synthetic processes to replace imported nitrate it is unlikely that the Germans would have brought about war when they did. They hoped for and expected speedy victory, but calculated on a long war.

Under normal conditions, plants obtain the nitrogen required by them as a result of a series of changes caused by bacteria. The protein matter contained in animal or vegetable remains is converted into ammonia, the ammonia into nitrites, and these into nitrates, in which form the nitrogen in the soil solution is absorbed through the rootlets and built up into proteins by the plant. Animals using the plants for food still further change the material, and animal proteins result. Carnivorous animals obtain their nitrogen from plants at second hand.

With the exception of one genus—the leguminosæ—all plants depend for their nitrogen on the cycle of changes described. Healthy peas, beans, wattles, &c., have growing upon their roots saprophytic organisms, which are capable of working up atmospheric nitrogen into a form assimilable by their hosts. This fact is at the basis of the long established custom of growing and ploughing in a green crop of some legume. As far as is known at present, there is no other natural

means of replacing from the atmosphere the combined nitrogen continuously liberated during combustion, &c. Once combined with others the element lends itself to many chemical changes. The difficulty lies in causing it to enter into combination.

It may be said that every known reaction for converting free nitrogen into some one or other of its compounds has been critically examined with a view to its commercial utilization. Much of this work was carried out before the war, but the desperate need for high explosives during the last five years resulted in the expenditure of millions of pounds on the industry in Germany, England, France, the United States of America, and other countries. As a result, its future trend can be forecasted with some degree of confidence.

The processes which have been used, and are still in operation on the large scale, are—

1. *The Arc process*, in which air alone, or mixed with excess of oxygen, is blown through a high tension electric arc. Several modifications of the original Birkeland-Eyde system have been introduced, but the principle is the same in all. It has been established that the action is almost purely thermal, and that there is only one primary product, namely, nitric oxide. The action $N_2 + O_2 = 2\ NO$ is strongly reversible at the temperature employed, so that the mixture coming from the arc is cooled as rapidly as possible. Cooling, however efficient, is not instantaneous, and dissociation of part of the nitric acid always occurs; the rest is converted into nitrogen peroxide, and, through the reaction of that substance with water, into weak nitric acid. The power requirements of this process are very large, and there is no prospect of its establishment except where very cheap water power is available. Further, nitric acid is difficult to transport, and to convert it into a salt for transport with subsequent reconversion into nitric acid would cost too much.

2. *The Cyanamide Process.*—This depends on the ability of calcium carbide to re-act with nitrogen according to the equation—$Ca_2 + N_2 = CaCN_2 + C$. Carbide prepared in the known manner is finely ground in an atmosphere of nitrogen, charged into special furnaces, and heated to about 800° C. in nitrogen obtained by the fractional distillation of liquid air. On completion of the process the product is re-ground, and may be treated with steam to give ammonia. The main reaction is not reversible, and the power requirements are low compared with those of the arc process, but the cyanamide process consists of a number of difficult operations.

3. *The Haber Process.*—This remarkable process, due to a member of that race from which has come the bulk of Germany's *intelligentia*, is a triumph of physical chemistry and of engineering. The velocity of the action $2N_2 + 3H_2 = 2NH_3$ increases with increasing pressure in the direction from left to right more rapidly than does the opposed action, in accordance with the law of mass action. For that reason operations are conducted at pressures of 180-200 atmospheres. At the highest attainable pressures the rate of reaction is still negligible at ordinary temperatures, so that an elevated temperature must be employed (700°). Rise of temperature increases the velocity of the back action also, but the difficulty so caused was overcome by the use

of a catalyst, which, while enormously accelerating the velocity of combination, has no effect on that of decomposition. For such a process to succeed commercially it must be continued, and the catalyst used (uranium, &c.), like other contact catalysts, is rendered inactive ("poisoned") by small traces of impurity, so that the nitrogen and hydrogen must be most carefully purified.

Other processes which, though they did not supply much, if any, fixed nitrogen during the war, are of interest, and may assume commercial importance, are—

1. *The Serpek process*, in which nitrogen passes over a heated mixture of carbon and bauxite. The product is Al N from which ammonia is formed by the action of water.

2. *The Bucher Process.*—This is the latest and, on its face, the simplest. It has aroused much interest in America, where it originated. Under the catalytic action of metallic iron nitrogen is absorbed by sodium carbonate at about 800° C., with the formation of sodium cyanide. The advantages claimed by the inventor for this process are its cheapness, arising from the low cost of the raw materials, including the nitrogen, which may contain a high proportion of carbon monoxide (*e.g.*, producer gas may be employed), and the comparatively low temperature. The roseate predictions of the future of the method, originated in 1916, have not yet been realized, work on a large scale paid for by the United States Government having failed, it would seem, to reproduce the results of semi-commercial tests. It is to be hoped that the difficulties will ultimately disappear, as the process has many advantages over its rivals. In this case, as in all, except that of the arc process, ammonia can be obtained.

From the point of view of the manufacturer of nitric acid, it is not a serious disadvantage that ammonia is an intermediate product. The oxidation of this gas by passing it mixed with air or oxygen over heated platinum was successfully carried out commercially by Ostwald ten years ago. Much attention has been devoted to the process during the war, and improved methods worked out in England and America. The main difficulty inherent in the method is the tendency of the oxidation to complete itself, water and nitrogen being the products. This is overcome by using smooth platinum, and preventing long contact of the gases with the catalyst. Platinum wire gauze and a rapid stream of gas are used.

The present position of the nitrogen-fixation industry appears to be that it is firmly established in Germany, as far as the Haber and cyanamide processes are concerned, and that arc processes will continue to be operated in Norway and other countries in which electricity can be obtained at about £1 10s. per H.P. year, or less. The Government of the United States of America has spent several millions sterling on cyanamide and modified Haber plants, but, in spite of the protests of chemists, appears to be inclined to scrap them. One reason for this is that the process for the synthesis of ammonia patented by the General Chemical Company had not, at the date of the signing of the armistice, been brought to the productive stage, serious difficulties still remaining to be overcome. In England the one solid achievement in this line of work was the production of an efficient ammonia oxidizer. Much

research was done on synthetic ammonia, and grandiose cyanamide plants were proposed, but some months before the conclusion of the war the programme was drastically curtailed, and when the war ended nothing had actually been done on the large scale. Alpine streams provide hydro-electric power for France, Italy, and Switzerland, and in each of these countries part of the required fixed nitrogen will doubtless still be obtained from the atmosphere.

The reasons for the favorable position of Germany in this respect are, firstly, the possession of experience, shared by the chemists of no other country; the enormous home demand for nitrogenous fertilizers; the pooling of interests of the great chemical firms in the Interessingemeinschaft; and the fact that the German financial interest in the Chilian deposits was never very considerable, and is now almost non-existent. During the war the labours of chemists in the allied countries promised to negative the first advantage, and, had it continued, would have done so. The second arises partly from the natural poverty of much of the agricultural land, and partly from the intensive culture system carried on. The third makes for economy, the waste, or intermediate, product of one industry being the raw material of another. It has often been stated that the Badische Anilin Fabrik took up the Haber process because it promised to solve the question of the disposal of huge quantities of dilute sulphuric acid. This is probably only part of the truth, but the statement shows clearly how one industry may decide the fate of another.

Under present conditions only factories enjoying special facilities appear likely to compete successfully with the great existing sources of fixed nitrogen by-product ammonia and sodium nitrate. Suppliers of these commodities will probably be able, for a time at least, to improve their process sufficiently to keep the price ratios much as they now are. From the point of view of defence the position is different. The safety of a country demands that, even when completely cut off from external supplies, it shall have available sufficient fixed nitrogen to provide all military requirements without necessitating a reduction in the amount necessary for the production of food. During the war this necessity was keenly felt, even in the United States of America, which, compared with any European country, is close to Chili, and, as indicated, considerable progress towards the realization of that aim has been made. Great Britain is not substantially better off than she was in 1914. As far as Australia is concerned, the position is rather more satisfactory. It is true that we have no nitrogen-fixation plant, nor even an ammonia converter, but we produce a surplus of fixed nitrogen in the form of ammonia owing to the small demands of Australian soils. In all the States the consensus of opinion is that except for special crops and in special localities the use of inorganic nitrogenous fertilizers at present prices is not justified by the increased yields, even where these result. Where nitrogen is required farmers, horticulturists, &c., prefer to use ammonium sulphate, blood and other animal wastes—fertilizers always likely to be available in this country. The reason for the small agricultural requirements of fixed nitrogen in Australia appears to be that the prevailing conditions so favour nitrification that the store of combined, but not available, nitrogen in the form of humus, &c., is rendered available by bacteria at a rate sufficient to meet the

current needs of the growing crops. On the other hand, the tropical plantations of Java, Sumatra, &c., require heavy fertilization, and provide a convenient market for the surplus ammonium sulphate.

The data in possession of the Special Committee established by the Institute of Science and Industry show the approximate position to be as follows:—

	Tons.
Fixed nitrogen (as ammonium sulphate and ammonia) produced and used locally	2,000
Fixed nitrogen (as sodium and potassium nitrates and mining explosives) imported	2,000
Total local consumption	4,000
Fixed nitrogen (as ammonium sulphate) exported ..	1,700

These figures show that under present conditions the Commonwealth could be rendered practically independent of imported fixed nitrogen if that now exported in the form of ammonium sulphate and ammonia were oxidized into nitric acid. Further, an estimated quantity of 900 tons is lost annually from beehive coking ovens. From the po'nt of view of national security we cannot calculate on this potential source, since, were sea traffic restricted, the erection of by-product recovery plants, always slow and expensive, would become practically impossible. It would seem, then, that in the extreme case of a complete blockade the present output of military explosives could not be increased except at the expense of the agricultural and mining industries, upon which our ability to maintain a resistance would ultimately depend. Only on the hypothesis of the effectiveness of the League of Nations can such a position be regarded with complete equanimity. The wise course is to prepare for the work, and the first step is the continuance here of the work on nitrogen fixation which has been carried so far in England and America. Figures supplied to an American chemist who inspected the Haber factory at Oppau* (McConnell, *Journal of Industrial and Engineering Chemistry*, Vol. 11 (1919) pp. 837-841) in March of this year led him to estimate that the cost of concentrated nitric acid produced at this factory by oxidation of synthetic ammonia would not exceed 1½d. per lb. as against a pre-war cost in America of 2½d. to 3d. per lb. for acid made by the old process. Such a low cost is unattainable in this country. The factory in question produced 90,000 tons of fixed nitrogen during the twelve months ending 1st November, 1918. An Australian plant producing one-twentieth of this amount would meet all our probable requirements. So small a plant would not be economical. Nevertheless it seems reasonable to estimate that the cost of acid made by this, or a similar process, would not exceed that of the acid made from imported nitrate, and our capacity to make it would reduce our liability to outside aggression, and enable us to resist it should it come.

* Since the armistice the German Government has granted a loan of about 200 million mk. to the Badische Anilin und Soda Fabrik for further developments.—Ed. S. and I.

Apprentice Education.

By CHARLES FENNER, D.Sc.*

EACH generation must hand on to the next its "heritage of skill and knowledge." With the Eskimo or the Australian aboriginal this heritage is small and general, but all-important, and is handed on by the elders in their tribal hunts and in the daily round of life. In our complex civilization, the "handing on" of this heritage is performed through the agency of the home, the workshop, and the school. The foundations of the specialized knowledge of some of the higher professions is mainly acquired in the school; the home is the only training ground in housecraft for the majority of our girls; the great body of manual workers and craftsmen receive the bulk of their education in the workshop (office, field, or factory).

In Elizabethan times, a high place in industrial organization was reached by the apprenticeship system, whereby a lad was indentured or bound to a master workman to be taught the full round of a trade. Times have changed. The separate and single master, with his apprentice living in his household, has given way to a maze of industrial organization, with large factories, much machinery, higher specialization of work, an increasing amount of repetition work, and a new conception of social and industrial life. With it all, there has been little or no change, nominally, in apprentice conditions. Compare the two following clauses from apprenticeship indentures:—

(*a*) A master's obligation to his apprentice, as set out in the "seaventh yeare of the reigne of our Sovraigne Lady Anne." (1708): "And the said Thomas Stokes doth promise and covenant to and with the said Thomas Selman and Richard Selman his apprentice *to teach or cause* the said Richard Selman *to be taught and instructed* in the trade, art, science, or occupacion of a broadweaver, after the best manner that he can or may with moderate correction, finding and allowing unto his said servant, meate, drinke, apparrell, washing, lodging, and all other things whatsoever fitting for an apprentice of that trade during the said term of seaven yeares."

(*b*) A master's obligation, as set out in the present year (1919): "The said Richard Brand (employer) covenants with the said Benjamin Cable (parent) and the apprentice and each of them that he will for the said term of five years from the fifth day of June, nineteen hundred and nineteen, *instruct or cause to be instructed* the apprentice in the process, trade or calling, business or occupation of a fitter, and shall pay to the apprentice weekly wages as follows," &c.

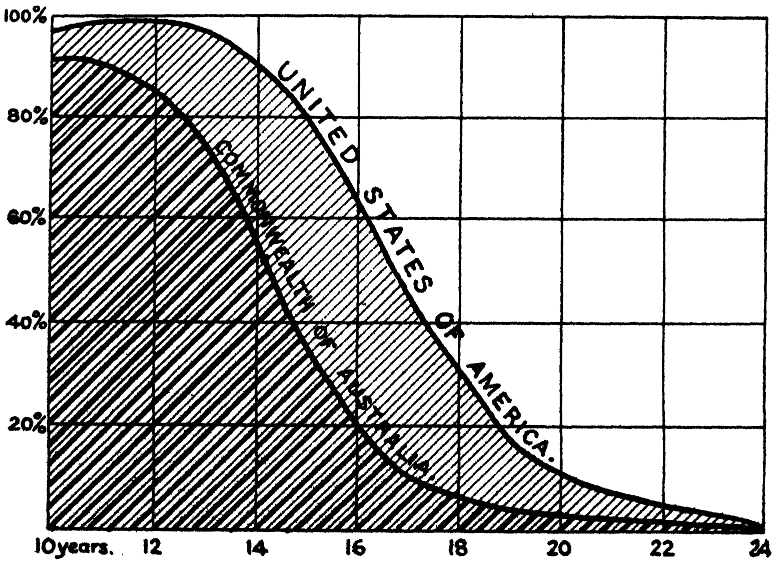
* Superintendent of Technical Education, S. Aust.

This most important portion of the apprentice agreement has undergone but slight verbal alteration during the whole two hundred years, but the apprentice conditions have absolutely changed. Intelligent modern work is based on a knowledge of scientific principles, and demands a considerable amount of general education. The work of all trades is highly complex, and is in a state of instability, since a fresh invention may overturn the whole organization of a workshop. Men trained along narrow lines may suddenly find their occupation gone.

Where hitherto one man worked in a shop, there are now numbers, and the foreman and master workman are busy men, who have little time to spare for the apprentice. There is no one to specially care for him, or to impart to him the general knowledge, the necessary mathematics, the skill in drawing and interpreting drawings, and the various other points that go to make an efficient craftsman. Stated briefly, the workshop under modern conditions is not constituted to train apprentices to be thoroughly efficient journeymen. Neither can a school alone produce an efficient tradesman. The problem can be solved only by a careful and well-considered correlation of school and workshop, especially during the early years of apprenticeship.

With an education system that is considered complete at the age of fourteen, or even earlier, and an industrial system that on the whole allows entry well beyond that age, there is a period of drift during which all the most useful lessons of the primary school are forgotten, and the newly-unfolding desires, ideals, and potentialities of early adolescence are clouded and dulled by idleness, blind-alley jobs, street gossip, and other similar character-destroying factors. There is an almost complete lack of purposeful guidance at this important age.

Those who are fortunate enough to have some schooling, with possible vocational guidance, between the age of 14 and 18, are very few. If we compare our latest reliable Australian figures with those of the United States of America, we are startled by the comparison.



This comparison is set out on a percentage basis in the foregoing graph. The most important portion of the graph is that dealing with individuals, between the ages of 15 and 18 years. The Australian figures are from our 1911 census, and those of the United States of America are for the same year from the report of the Commissioner of Education of the United States.

The actual figures for the age-group 15 to 18 years are:—

Population over 15 years and under 18 years.	United States.		Australia.	
1. Estimated total population (15–18)	5,483,633	100 %	268,993	100 %
2. Number enrolled in schools ...	3,060,244	55 %	32,343	12 %
3. Number not attending any school ..	2,423,389	45 %	236,650	88 %

These figures include all those attending schools of any kind, public or private, either day school or evening only. It may be assumed that the greater number of those quoted as receiving education between 15 and 18 are part-time students, receiving education supplementary to that of the office and workshop. It is clear that Australia is lagging behind in the matter of adolescent education.

An important phase of adolescent education is the part-time education of apprentices. A very promising start in this matter has been successfully made in the State of South Australia under the provisions of an Act for the compulsory technical education of apprentices. The chief features of this Act, as described by the Minister for Education (Hon. W. H. Harvey), are that benefit will be derived by (*a*) the apprentice; (*b*) the employer; and (*c*) the State. The apprentice will benefit by receiving from the best skilled men in his trade a complete and graded course of instruction that must not only make him a better craftsman, but a citizen with broader knowledge, wider interest, and a greater capacity for happiness. The employer will benefit in having the men developed to their highest ability, with a knowledge of the fundamental principles of the trade, and with a broader conception of their craft than can be gained in any single shop. The State as a whole will benefit by having a thoroughly trained body of craftsmen throughout the skilled trades; up-to-date methods will be commoner, and the State thus rendered more self-dependent.

While the benefits are thus three-fold the obligation is likewise three-fold, and this is recognised in the Act. The apprentice is required to give to his classes his earnest care and attention, and in addition, to give up at least one evening per week of his leisure for the purpose of study. The employer is to allow his apprentice one half-day (4 hours per week) for the purpose of attending day classes in the subjects of his trade, and also periodically to supply information concerning the progress of the apprentice at his shop work. The State must provide the schools and classrooms, and pay the full costs of all necessary tuition.

The chief points of the Act may be summarized as under:—

(*a*) The Act applies to indentured apprentices only.

(*b*) It applies only to such trades and districts as are proclaimed by the Minister.

(*c*) At present it is being applied in the metropolitan districts of Adelaide to all apprentices in the ironworking, woodworking, and printing trades.

(*d*) The classes are held during one afternoon per week (4 hours) in ordinary working hours, and one evening per week (2 hours).

(*e*) The subjects taught in the first years are the practice and theory of the trade, trade drawing, and trade arithmetic or English.

(*f*) Each apprentice must satisfactorily complete a graded three-year course.

(*g*) The instructors are selected from the most highly qualified tradesmen available.

(*h*) The classes, equipment, staff, and subjects of instruction are advised upon by trade committees consisting of representatives of employers and employees "skilled in the trade concerned."

(*i*) The year is divided into three terms of 14 weeks each; this involves 252 hours of instruction per year.

(*j*) Once in each term the employer receives a report from the school as to each lad's progress; the school receives a report from the employer as to the work done in the shop; the parent receives a report setting out the progress in both school and workshop. Thus the home, school, and shop are closely correlated.

(*k*) At the completion of his course, the apprentice will receive a certificate stating the nature of the course completed, and space will be reserved on same for the certificate of the employer that the indentures of apprenticeship have also been satisfactorily completed.

(*l*) No apprentice may be indentured under this Act without first serving a probationary period of at least three months, during which time he attends his classes.

(*m*) The whole question of apprentice education and training, the extension of the apprenticeship principle to other trades, the modification of apprentice conditions so as to make them more closely fit modern conditions—all these matters are in the hands of a representative committee called the Apprentices Advisory Board.

During the few months that the Act has been in operation, certain facts have been noted that require remedy. Chief among these is a lack of guidance. The majority of boys have drifted into their trades without having any regard to their special fitness or aptitude therefor; some of these lads regard their indentures as irksome, and it is partly for this reason that the bonds of apprenticeship are at present, in some cases, lightly regarded.

A further difficulty is the lack of preliminary education of the right kind. This difficulty is wrapped up with that mentioned in the last paragraph, and might best be overcome by a system of pre-vocational or "junior technical" schools, in which a good course of modern education (mental and manual) is given, from 12 to 15 years of age, whereby it will be the chief business of the teachers to discover the special aptitudes of each lad, and to assist in placing him in that trade or profession for which his abilities are suited and the demand exists. In the last year of the course it is intended to embrace, in addition to the advanced stages of craft work, such subjects as computations of costs, some historical studies, and an introduction to economics.

Industrial conditions, which have so important a bearing on this question, are somewhat different in South Australia from those of other States. For instance, no limitation is placed on the number of indentured apprentices, except in one trade. It has been suggested that a step towards further development would be a Compulsory Apprenticeship Act, to cut out that undesirable drifter, "the improver." Another suggested movement for the uplift of the status of the skilled and efficient craftsman is a "Registration of Tradesmen" Act, such as is in force in some States for plumbers and electrical workers. These are, however, matters for the future. For the present, a good system of pre-vocational schools (12-15 years of age), followed by apprenticeship under an Act such as that outlined above for apprentices' part-time education, will give to each trade a greatly increased efficiency, to the workmen a higher status and increased joy in life, and to the general public a body of skilled craftsmen that will be an invaluable asset for the State.

"They gave it into your hands, Australians, when the bullet took them. It lies in your hands now—you, the younger generation of Australia; you, the men of the A.I.F., most of whom are still young Australians; even to the young Australians still at school. Australia lies in your hands now, where those men, dying, laid her. This is not mere fancy—it is the simple, splendid truth. You have a much bigger task facing you than the Australian Force in France and at Anzac had. It is the same great task really; but the A.I.F. only began it."

—C. E. W. BEAN.

Personal.

DR. S. S. CAMERON.

Australia is apt to pride herself upon her rich agricultural possessions. With the exception of isolated individual instances, however, her resources are not being fully exploited, and development is slow. There have been some noteworthy instances where production has been increased by the efforts of the plant-breeder, and slightly more numerous are the examples of the beneficial influences which stock-breeders have exerted. A high level of general farming has also been attained by the few. It is these few departures from the general practice, however, which emphasize the prevailing low standard. Several explanations might be given to account for our slow progress, but probably one of the most important factors that has operated has been the lack of encouragement given to the scientist.

If it is true that the path of the agriculturist is a difficult one, it is equally true that the path of the agricultural scientist is no less easy. When the late Mr. William Farrer, after having exhausted his considerable private means upon the investigation of rust in wheat, was eventually permitted to continue his experiments under Government subsidy, he was expected to show "results" weekly. He was given a beggarly pittance of £300 a year, and the work which he was able to accomplish has been worth many millions of pounds sterling to the Commonwealth. Since those days, agricultural scientists have received more tolerance, although as a rule their rate of remuneration has undergone no appreciable change. The distrust and suspicion with which the scientist was viewed is gradually being lessened, but he is still expected to perform miracles of quick development and sudden transformation, rather than bring about a gradual improvement of farm practice.

Governments of recent years have given closer consideration to the development of primary industries, and the State Departments of Agriculture are assuming a greater importance. Those who are familiar with their work will regard the funds allotted them as money well spent. More and more the work of the departmental scientist is being reflected in the quicker progress of one or other branch of agriculture, and he is entitled to much of the credit for any progress that is made.

In the development which has taken place in Victorian agriculture within the last ten years, the scientific staff of the Department of Agriculture has played an important part. Since 1909, in wheat-growing alone, there has been an increase of over 4 bushels per acre to the average yield when compared with the previous decade. From 8¼ to 12½ bushels is a substantial difference, and the seasons cannot be held responsible. The decrease in stock mortality from preventable disease is another highly satisfactory result, and has saved the country many times over the salaries which the scientists responsible for the system of herd examination were successful in establishing.

To the Director of Agriculture, Dr. S. S. Cameron, must be attributed an important part in the success won by his Department. It was he who, upon his appointment in 1911, completely re-organized the administration, involving important changes in the *personnel* of the scientific staff, and who secured, and has maintained, harmonious relations between the officers of the Department and the farmers. Before accepting the position, Dr. Cameron had won a wide reputation in the field of veterinary science, particularly in regard to investigational work on the inter-communicability of human and animal tuberculosis. It was in view of his success as a specialist that the wisdom of appointing him as Director of Agriculture was, in some quarters, questioned. But the new Director soon displayed what was of greater value than a broad, general training in scientific agriculture, viz., marked administrative ability. It was his business to see that the work of the Department was done efficiently, and that responsibility was delegated to responsible officers. Under his administration, the value of science has been demonstrated, and the gap between the farmer and the scientist has been reduced. He selected the right men for the right places. Mr. W. A. N. Robertson, B.V.Sc., for instance, was appointed Chief of the Stock Division; Mr. A. E. V. Richardson, M.A., B.Sc., was brought from South Australia and made Agricultural Superintendent; Mr. Colebatch, B.Sc., M.R.C.V.S., now Principal of Roseworthy Agricultural College, was another of his early appointments; and so was Mr. Temple Smith. Others who have since joined the Department have won the confidence and esteem of the farmer, which is the first step before much useful work can be performed.

Dr. Cameron is a native of Cumberland, England, his ancestors having been engaged in farming for many generations. Upon leaving school, he was articled to a solicitor, but the law failed to attract him, and after two years as a student he entered the then newly-established Veterinary College at Edinburgh. He proved himself a brilliant scholar, and was medallist in theoretical chemistry, practical chemistry, materia medica, botany, and physiology, and won a bursary for the highest aggregate marks during the first two years of the course. Upon graduating as M.R.C.V.S., he was selected by his college to compete for the Fitzwygram prize, and gained fourth place in competition with twelve graduates of other colleges. Largely as a result of observations made during his early experiences amongst farm live stock, Dr. Cameron's thoughts were turned in the direction of the State control of animal diseases communicable to man, and he devoted himself to the study of tuberculosis and such like diseases. Since then, both in New Zealand and in Victoria, Dr. Cameron has played an important part in the moulding and administration of legislation for the safeguarding of public health.

Dr. Cameron's first position in Australia was as Lecturer and Hospital Surgeon in the Melbourne Veterinary College. He acted in that capacity from 1889 to 1894, when he accepted an appointment in New Zealand. His name is associated with the establishment at Dunedin of the first public abattoirs in New Zealand. He returned to Melbourne in 1896 as Principal Veterinary Officer of the Board of Health, and collaborated with the late Dr. Gresswell in the preparation of the Meat

Supervision Bill. The passage of that legislation was marked by the abolition of 36 out of 43 of the private slaughter-houses previously in existence around Melbourne, and by the concentration of slaughtering in properly constructed and strictly supervised abattoirs. It was also immediately followed by the compulsory branding, after inspection, of all meat fit for human consumption. Big changes affecting the general welfare of a community are sometimes effected quietly. In this case, a complete revolution was carried out, and the methods of handling one of our most important foodstuffs was entirely altered. Previously, there was practically no check upon the activities of the slaughterman, and very few safeguards against the consumption of diseased meat. Frequently foul and insanitary premises were used, and all was grist that came to the mill. Rigid inspection now enforces the observance of clean conditions and the destruction of harmful meat. This public health reform was closely followed by another of similar importance—the passage of the Dairy Supervision Act. The difficulties in this case, however, were greater. The number of dairymen who would be affected by Government interference was very great, and the problem of providing adequate supervision was much more complex.

The responsibility of evolving a scheme whereby not only might the public interest be served, but that existing private interests might not be too hardly and, perhaps, unfairly dislocated, fell upon Dr. Cameron's shoulders. His knowledge of the technicalities of both aspects of the problem, however, enabled him to create smooth-working and effective machinery, and he was therefore transferred to the Department of Agriculture to administer the Act.

Upon his appointment as Director of Agriculture in 1911, Dr. Cameron decided upon the re-organization of the Department, and he did not scruple to make drastic alterations. Having himself had a scientific training, he fully realized the value of the scientist. His early experiences on his father's farm, and a year's course in Agriculture at the Edinburgh University, taken concurrently with his veterinary studies, had also furnished him with considerable practical knowledge of agriculture. Of more importance still, it enabled him to take the practical man's view-point. Having gathered the best available men around him, he was therefore able to direct their energies in full sympathy with the farmer's outlook, realizing that friendly co-operation between the scientist and the farmer must be obtained if either was to do effective work. A distinct change now marks the attitude of the one to the other, and a vast amound of good has been accomplished.

Probably the best known of the many reforms which Dr. Cameron has personally carried out since his association with the Department of Agriculture was the issue of Government certificates of soundness for stallions. He succeeded, against strong opposition, in securing the examination of stallions for hereditary unsoundness. This was in the days before he was Director, and the fight which he put up, and finally won, for the adoption of this principle marked him out as a man having the courage of his convictions. It also stamped him as a man of sound initiative, for since the practice was first introduced in Victoria in 1907, it has extended to many other stock-raising countries. It has been adopted in both England and Scotland, and in many of the States of

America. In most of those countries, legislation was passed to enforce its observance. At the present time, there is a Bill before the Victorian Parliament to make such examination compulsory; and it speaks well for the influence and standing of the Agricultural Department, and particularly of the live-stock division, that for the past twelve years it was able, merely as an administrative function, to obtain recognition of the principle.

When the question of the establishment of a Veterinary School and Research Institute at the Melbourne University was mooted, Dr. Cameron took a prominent part in vitalizing the movement and bringing it to fruition. The creation of a Chair of Agriculture marked another stage in the history of the Melbourne University, and one from which should date big advances in the practice of agriculture. The interest which Dr. Cameron has taken in this new school is not merely official, but is intensely active and sympathetic. "Science has already been of great assistance to the farmer," he stated recently, "and the State has everything to gain from securing thoroughly-trained investigators. Science is essential to progress in agriculture, and I am firmly of opinion that the future increase in agricultural output from the State lands will be in direct ratio to the graduate output from the University." There is no need to turn to the United States for confirmation of this belief. The success of the Werribee Experimental Farm is sufficient evidence of the value of scientific investigation, and although it would be difficult to express in exact monetary terms the results of the demonstrations which have already been carried out, their influence has been pronounced and widespread. The usefulness of the Department of Agriculture has been strengthened by the addition of young, zealous trainees to its staff, and as time goes on, and more and more graduates are employed upon the problems of primary production, not only will the prestige of the Department be increased, but the State will reap substantial benefits.

As a member of the Executive Committee of the Advisory Council of Science and Industry, Dr. Cameron's wide knowledge of agricultural industry, and his practical criticism of the various problems dealt with, has proved of great value. During the time he has been a member of that body, he has assisted very largely in bringing about co-operative investigation, not only between the States, but between the Commonwealth and the States. It was a fitting tribute to his ability that his should have been the first name to be recorded on the register of the Melbourne University as Doctor of Veterinary Science (D.V.Sc.). Dr. Cameron won this distinction in 1909, and was therefore the first man in Australia upon whom this degree was conferred.

REVIEWS.

INDUSTRIAL WELFARE WORK.

Bulletin 15 of the Commonwealth Institute of Science and Industry opens up new ground by dealing with problems of industrial organization and management. In 110 pages, it surveys the history, the motive, and the methods of what is variously described as "welfare work," "model employment," "employees' betterment," &c. Such a Bulletin comes most opportunely at this juncture, for there is in Australia a rapidly-growing recognition that the future prosperity, and even the national safety, of the Commonwealth depends upon the establishment of more satisfactory relations between the two big factors concerned in the production of wealth. But as the author of the Bulletin points out in his preface, "those relations are far wider than questions of wages and hours of labour, and any policy which confines its attention to those two matters alone is inadequate, and liable therefore to fail. A comprehensive industrial policy looks further afield, goes deeper, and faces such matters as the whole aim of industry, the responsibilities which fall on the shoulders of a man who employs other men, the effect of industrial conditions upon the worker and the work, the well-being of the employee outside working hours, the distribution of the wealth produced, and finally the participation of the employees in the management and control of industrial operation." This Bulletin sets out to show what has been done along these lines by wide-awake employers in Europe and America. The employment policies of such firms as Ford, Goodyear, Cadbury, Lever, Krupp, &c., are analyzed, and much of the experience obtained by the British Ministry of Munitions is set forth. Eighteen chapters deal with such matters as the creation of a healthy, safe, pleasant factory environment, methods of engaging and dismissing workers, industrial fatigue and its relation to hours of labour, rest-pauses and holidays, discipline, methods of payment, aids to wages—such as stores, provident funds, profit-sharing and co-partnership, dining-rooms, social and educational activities, recreation, housing, and welfare work for juveniles. The last chapter deals with the conditions essential to successful welfare work, and is a frank, blunt statement of the whole matter.

The information contained in this Bulletin will come as a revelation to many Australian employers, and employees, for welfare work is as yet only in its infancy in this country. A supplementary Bulletin is being prepared by the Institute, describing the character and extent of welfare provisions in Australian factories and shops. Meanwhile, all who wish to get new light on the vexed problem of industrial relationships are recommended to secure this Bulletin, which can be obtained for 6d., post free, from the Secretary, Institute of Science and Industry, 391 Bourke-street, Melbourne.

THE HARDWOODS OF AUSTRALIA AND THEIR ECONOMICS.

By Richard T. Baker, Curator and Economic Botanist, Lecturer on Forestry, Sydney University.

Technical Education Series, No. 23, Government Printer, Sydney, 1919, pp. xvi. + 522; 25s., + postage, 4s. 2d.

With the appearance of this compendious volume by Mr. Baker will disappear the reproach that Australia, which has a magnificent asset in its forests, has not any reliable, complete account of the timbers obtained from them.

Mr. Baker's works are generally characterized by a combination of rare beauty and absolute economic value—such as "The Cabinet Timbers of New South Wales," and, along with Mr. H. G. Smith, "A Research on the Pines of Australia." Their joint production on "The Eucalypts" paved the way for the present volume. It resulted in setting a standard of scientific accuracy for the identification of our eucalypts, and overcoming the confusion of common names, that all orders for Australian oils are given under the scientific names, the common names being entirely discarded, right from the oil distiller in the bush to the retailer in the city. It is to be hoped that "Hardwoods" will have a similar result in the timber trade. Mr. Baker gives many illustrations of this hopeless confusion, *e.g.*, bluegum for four well-known species—*E. globulus, maideni, saligna, tereticornis*. The first two have pale or white timber, and the latter two have red. Similarly, our best ironbark is *E. paniculata*, while Tasmanian ironbark is *E. virgata*, a much inferior wood. The plea is well made to drop the common names, as has been already done in New Zealand, South Africa, and South America.

When we turn to the Systematic List (p. 408), one realizes the great diversity of our hardwoods. Here we find no less than 38 orders, including 108 genera; but the one genus which stands out in great predominance as a timber yielder is eucalyptus, which exceeds all the others put together. Mr. Baker describes in this work no less than 141 species out of a total of about 200 known species, in which are to be found, perhaps, the greatest variety of timber of any other genus in the world. The eucalypts form three-fourths of our forest flora. As nine-tenths of our forest trees are hardwoods, our forestry problems and our re-afforestation work will deal principally with hardwoods. On page 137 is given a good indication of the characteristics of the barks on which the more familiar classification of eucalyptus is based, viz., bloodwoods, mahoganies, boxes, tallowwoods, stringybarks, woollybutts, blackbutts, gums, peppermints, ashes, and ironbarks.

In the main classification of the whole of the timbers, colour is relied upon as the best general method, and a fine list is given of the timbers classed under dark red, red, pink, grey, chocolate, yellow, pale, and white. This is often sufficient to determine the species, and is the colour of a newly-planed surface. Sometimes colour changes take place after exposure to air. It is on account of the value of colour as a basis of classification that so many coloured plates have been reproduced. These reflect the greatest credit on all concerned in the preparation of timber specimens, in photographing, and in colour printing. There are 126 beautiful plates. It is a pity that such a colour classification is not based on an international colour code, which banishes indefiniteness about terms like pink, pale, grey, &c. A convenient code is that by Paul Klincksieck—*Code des Couleurs*—which depicts and numbers 720 shades; or there are more elaborate ones.

The next characteristics taken are weight, texture, hardness, and grain.

Under weight, Mr. Baker prefers the trade custom of the weight of a cubic foot. The moisture supposed to be in well air-dried timber is 10 to 18 per cent. It is the custom in the United States of America to adopt 12 per cent. as a standard. It would have improved the references if the specific gravity had also been added. No one likes making calculations of division by 62.425. As example, at first glance we see *E. paniculata* (black or white ironbark), respectively 69½ and 64 lbs.; *E. globulus* (Tasmanian bluegum), 63 lbs., all heavier than water.

An excellent section is that dealing with wood structure (pp. 15-21). Here is given a good account of what constitutes the timber of commerce, the structure of wood fibre, and the relation of per cent. to weight, the relation of hardwood and sapwood to colour, &c. This is a section that we would like to see much extended, and the other elements of the wood might be illustrated. There are seven types of wood fibre shown, and the microscopic examination of the disintegrated wood elements is often sufficient to identify a timber. This section is greatly helped by the many (64) photomicrographs (X45) of cross sections, longitudinal, radial, and tangential sections. This requires an enormous amount of work, and many blocks, and it is a question whether the method adopted by Mr. N. W. Jolly in his illustrations of Queensland timbers (Forestry Bulletin No. 1, Queensland) would not be of more value for the foresters, traders, builders, &c. There are photographic pictures of the planed surface—nine on an octavo page, of a magnification of two and a half times. They can be further magnified by the reader, by using a hand lens, and so would correspond to the actual examination of a hand specimen.

Amongst the new and interesting features introduced are:—

1. Hardwoods, in grades of hardness (p. 383), under extremely hard, very hard, hard, moderate.

2. Comparative combustibility of timbers (p. 28).

3. Lists of timbers suitable for various purposes, *e.g.*, for furniture, shipbuilding, carriage-making, bridges, sleepers, wharfs, wood pavements, wood carvings, &c.

Engineers are not in complete agreement as to methods of testing hardness of timber. The impact method, as approved by Mr. Baker, must be carried out in at least three different planes, in relation to the fibres, &c.; and on consulting Professor Warren's and Mr. Julius' lists and methods, we find a fair amount of diversity, *e.g.*, Baker—very hard, *E. paniculata;* hard, *E. acmenoidies, E. microcorys, E. globulus, E. maculata, Syn. laurifolia;* while Warren gives almost a reversed order—*Syn. laurifolia, E. maculata, E. paniculata, E. globulus, E. acmenoidies, E. microcorys.* This is a section which requires the co-operation of the engineer.

The section on combustibility brings out the great fire-resistance of *E. fletcheri* and *Syncarpia laurifolia* (turpentine), and this property alone justifies afforestation of these species.

Useful hints are to be found under every section, and should result in the greater demand for Australian timbers, *e.g.*, under shipbuilding, we see turpentine for cobra resistance; brown box for wear without splintering; *E. maculata* for planking below water-line, owing to flexibility, &c. Mr. Baker strongly recommends stringybark for furniture making.

The book is divided into three parts:—

Part I. deals chiefly with the physical properties and structure.

Part II. is the main part, containing a description of the individual species of hardwoods (350 pp.) The method is uniform throughout, describing the timber as follows:—Description and uses, transverse tests, anatomical features; and, in small type, the main systematic points, and the geographical range. All the more important kinds have on the opposite pages a colour plate, and three photomicrographs.

Part III. contains the technological section, followed by various lists of uses, bibliography, systematic list, index of plates, and a very complete general index.

The seasoning of timber forms a most important section, and is divided into natural and artificial. The former gives a general account of seasoning, and also the difficulties with eucalyptus.

The methods of stacking—horizontal, oblique, triangular, and perpendicular—are well-illustrated and described. Under artificial seasoning we find electrical, kiln drying, Powellization and Kyanizing (using corrosive sublimate), and the method of Epinoy (using alkaline bi-chromates). Seasoning is the most important factor in the technology of Australian timbers, and Mr. Baker states that much research is required to evolve satisfactory methods, owing to the peculiar difficulties of eucalyptus. The author does not express any definite opinion of the relative value of the various methods.

There is so much of value in the book, and so much that is new, that we hesitate to ask for additions. As its use is bound to create inquiries from everywhere, such questions as the following need answering:—The available supply of the species; the amount of afforestation going on; the forest diseases (*e.g.*, *Fomes*, and *Polyporus spp.*); diseases of stacked timber and fallen trees, sleepers (dry rot); and certain other physical properties, such as holding power for nails and dog-spikes, &c.

Mr. Baker deserves congratulations, not only from all those for whom he has catered (as mentioned in his preface), but from the whole Commonwealth; and he has raised a lasting monument—in "Hardwood"—to his fame as the leading authority on Australian timbers. The book is dedicated to the Governor-General, Sir Ronald C. Munro Ferguson, P.C., G.C.M.G., a great advocate of Australian forestry work. Our copy was presented by the author. Copies are available at the Technological Museum, Sydney.

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